PRICE $1.00

Assembling
and Using Your...

# Heathkit

## PREAMPLIFIER

MODEL WA-P2

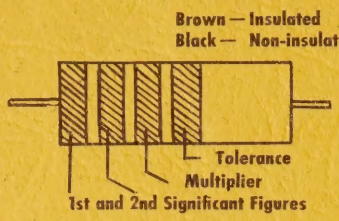
HEATH COMPANY
A Subsidiary of Daystrom Inc.
BENTON HARBOR, MICHIGAN

595-89

# STANDARD COLOR CODE — RESISTORS AND CAPACITORS

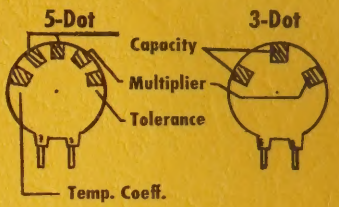
| INSULATED UNINSULATED Color | FIRST RING BODY COLOR First Figure | SECOND RING END COLOR Second Figure | THIRD RING DOT COLOR Multiplier |
|---|---|---|---|
| BLACK | 0 | 0 | None |
| BROWN | 1 | 1 | 0 |
| RED | 2 | 2 | 00 |
| ORANGE | 3 | 3 | ,000 |
| YELLOW | 4 | 4 | 0,000 |
| GREEN | 5 | 5 | 00,000 |
| BLUE | 6 | 6 | 000,000 |
| VIOLET | 7 | 7 | 0,000,000 |
| GRAY | 8 | 8 | 00,000,000 |
| WHITE | 9 | 9 | 000,000,000 |

### AXIAL LEAD RESISTOR

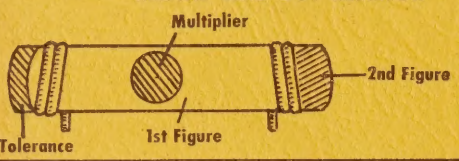



Wire wound resistors have 1st digit band double width

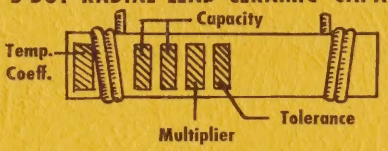
### DISC CERAMIC RMA CODE



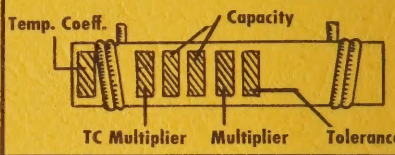

### RADIAL LEAD DOT RESISTOR



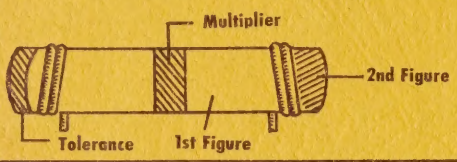

### 5-DOT RADIAL LEAD CERAMIC CAPACITOR



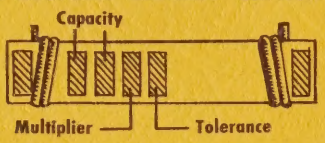

### EXTENDED RANGE TC CERAMIC HICAP




### RADIAL LEAD (BAND) RESISTOR




### BY-PASS COUPLING CERAMIC CAPACITOR



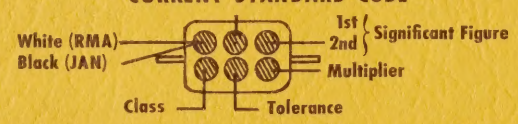

### AXIAL LEAD CERAMIC CAPACITOR


The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

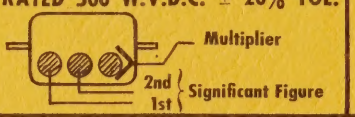
## MOLDED MICA TYPE CAPACITORS

### CURRENT STANDARD CODE

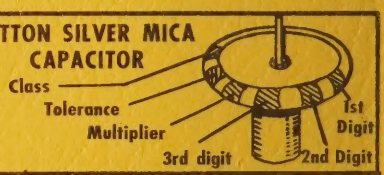



JAN & 1948 RMA CODE

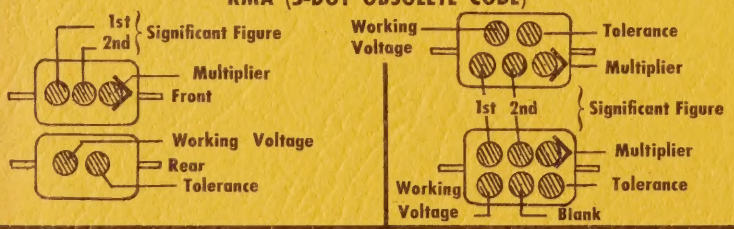
### RMA 3-DOT (OBSOLETE) RATED 500 W.V.D.C. ± 20% TOL.



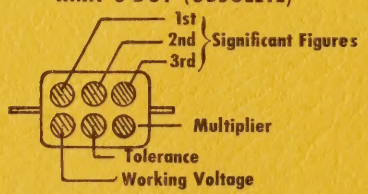

### BUTTON SILVER MICA CAPACITOR



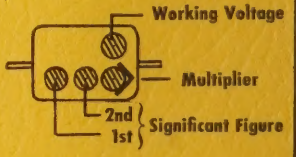

### RMA (5-DOT OBSOLETE CODE)




### RMA 6-DOT (OBSOLETE)

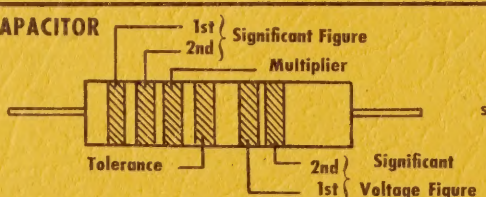



### RMA 4-DOT (OBSOLETE)




## MOLDED PAPER TYPE CAPACITORS

### TUBULAR CAPACITOR

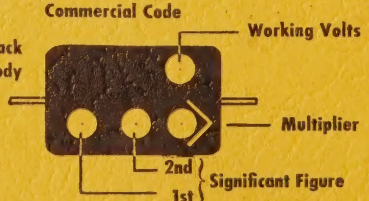



Normally stamped for value

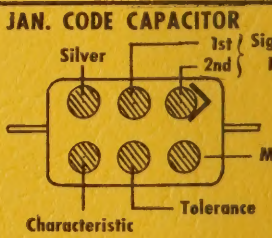
A 2 digit voltage rating indicates more than 900 V. Add 2 zeros to end of 2 digit number.

### MOLDED FLAT CAPACITOR

Commercial Code



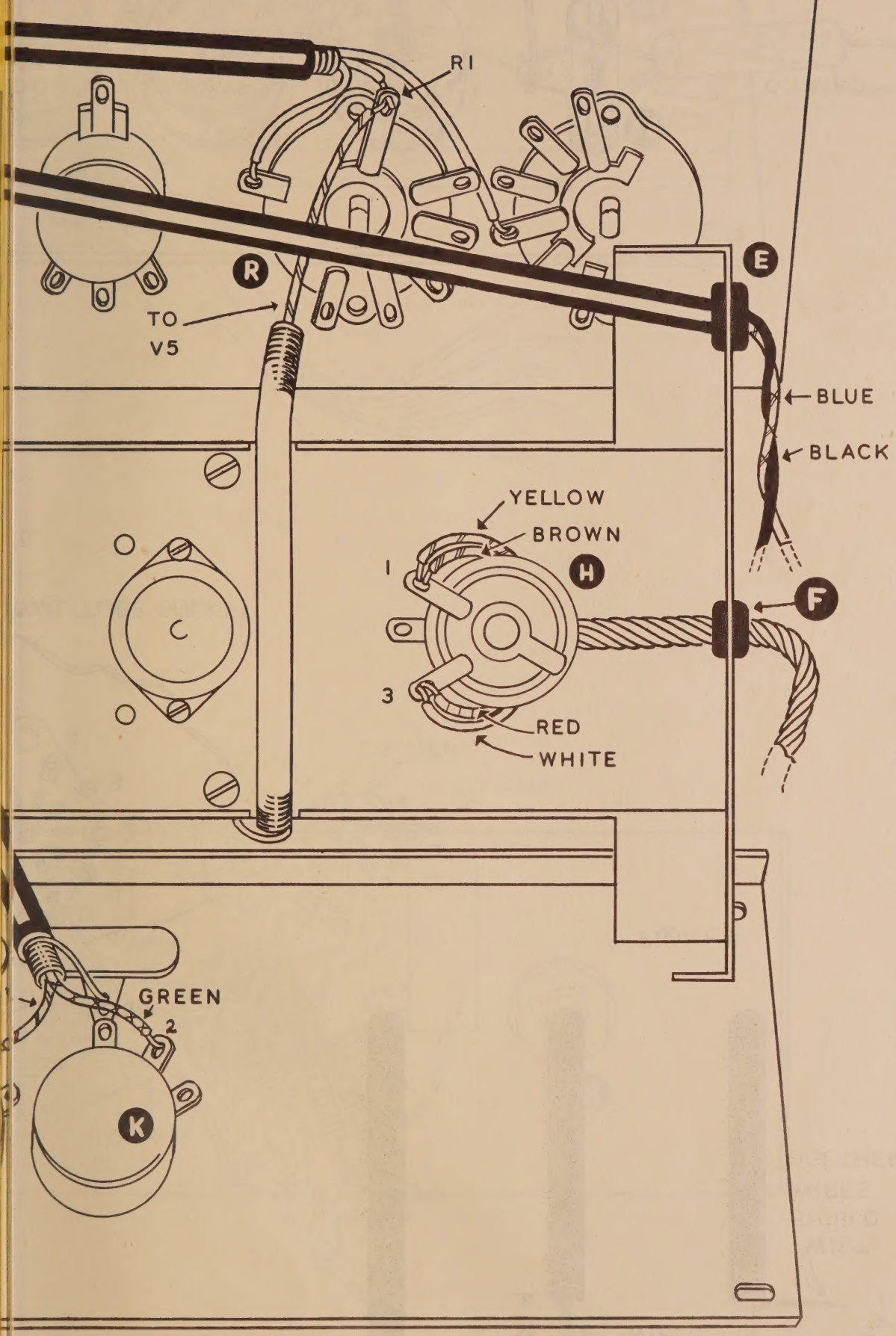

### JAN. CODE CAPACITOR




The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

Courtesy of Centralab




G

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|---|---|---|---|
| BLACK | 0 | 0 | None |
| BROWN | 1 | 1 | 0 |
| RED | 2 | 2 | 00 |
| ORANGE | 3 | 3 | ,000 |
| YELLOW | 4 | 4 | 0,000 |
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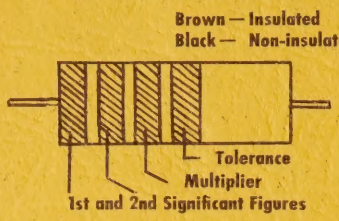


Wire wound resistors have 1st digit band double width

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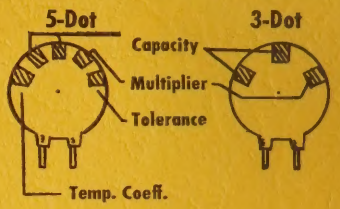


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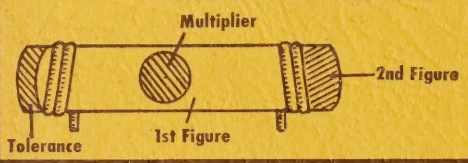


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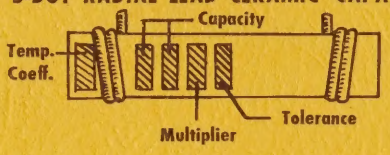


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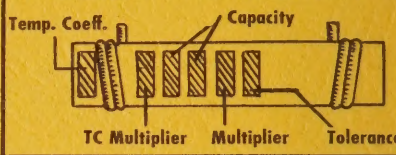


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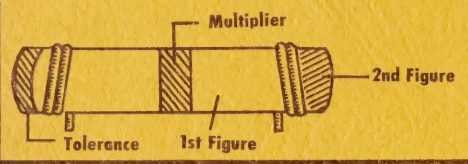
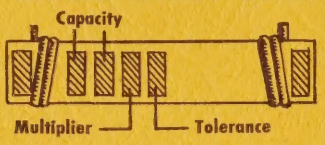



### BY-PASS COUPLING CERAMIC CAPACITOR

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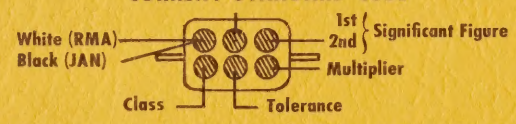


JAN & 1948 RMA CODE

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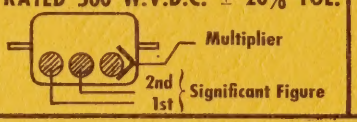
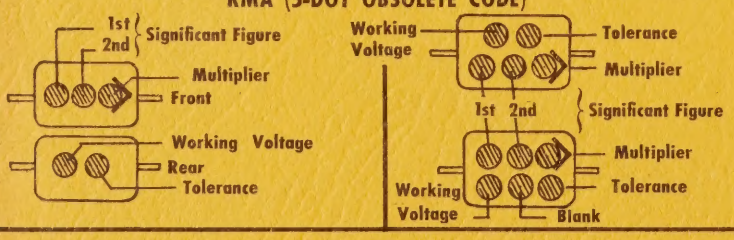
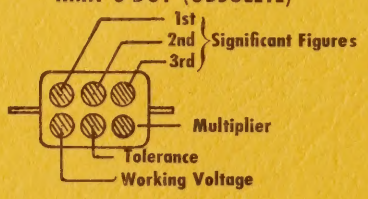



### BUTTON SILVER MICA CAPACITOR

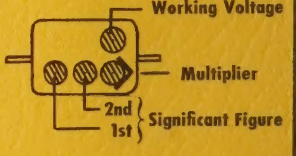

### RMA (5-DOT OBSOLETE CODE)




### RMA 6-DOT (OBSOLETE)

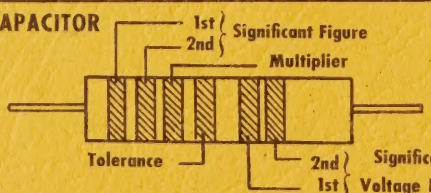



### RMA 4-DOT (OBSOLETE)




## MOLDED PAPER TYPE CAPACITORS

### TUBULAR CAPACITOR

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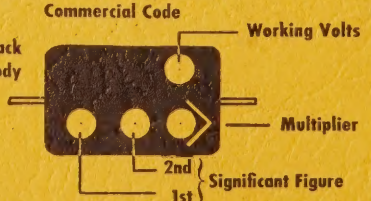
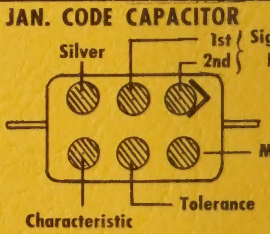
Commercial Code




### JAN. CODE CAPACITOR

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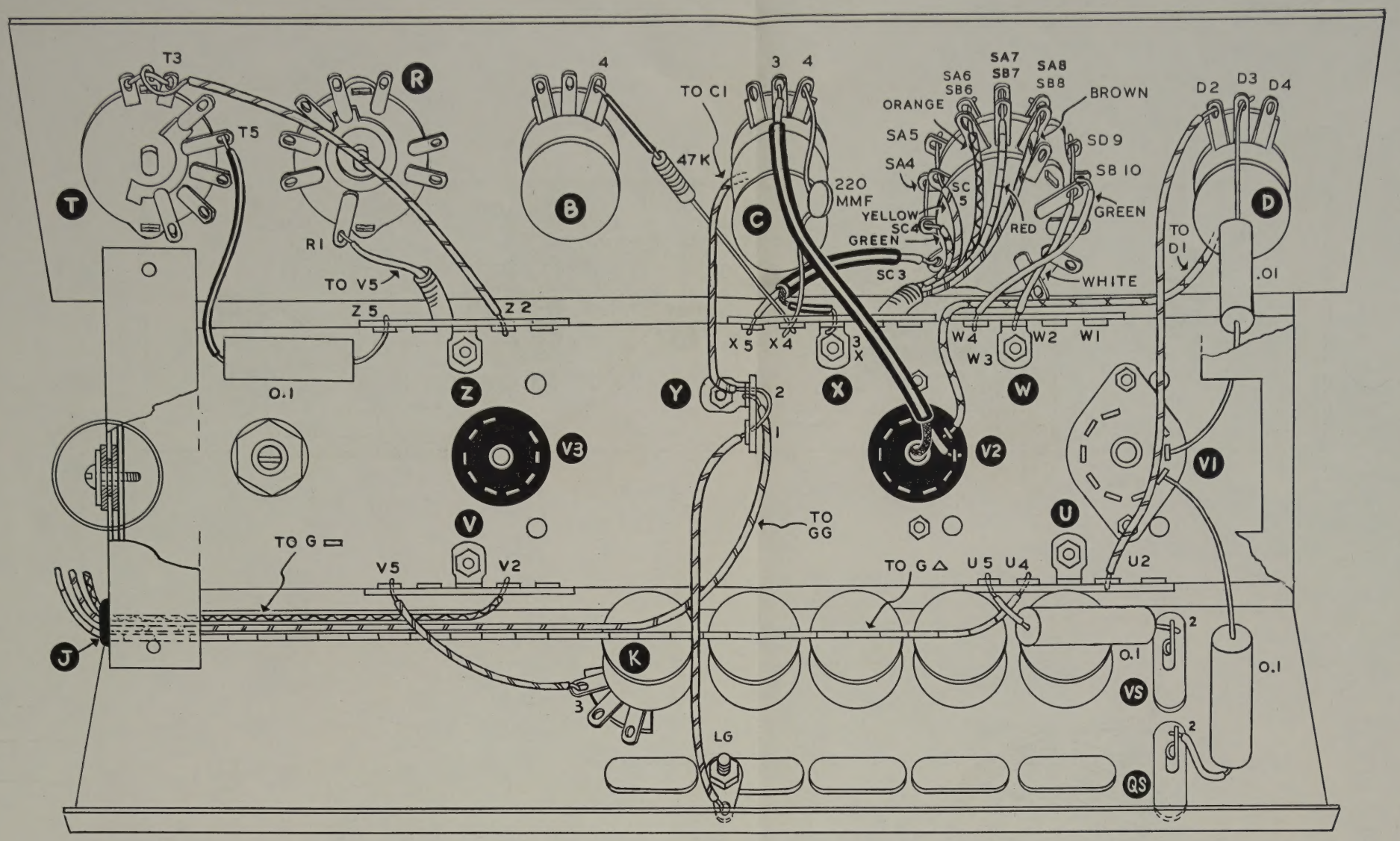
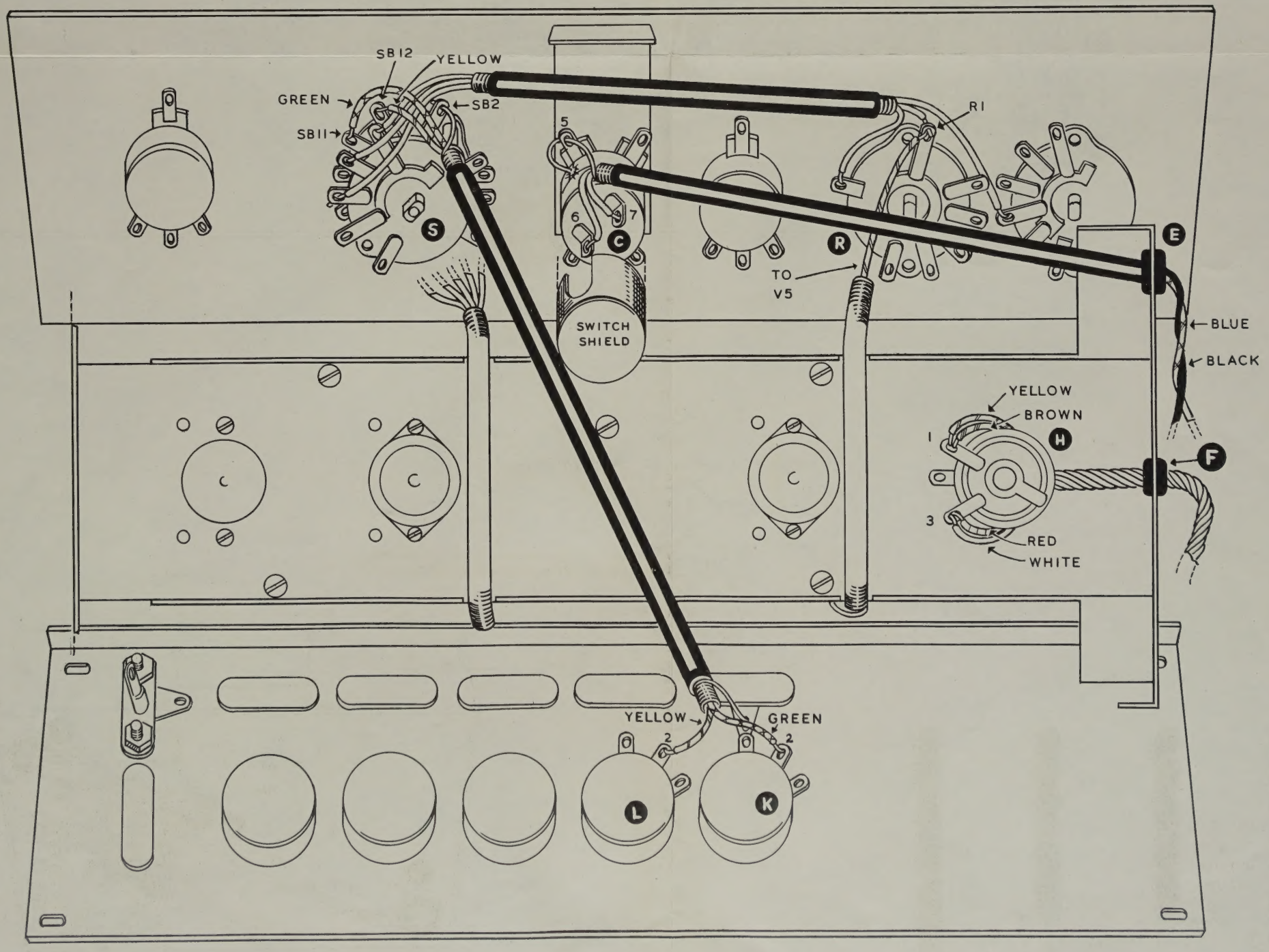
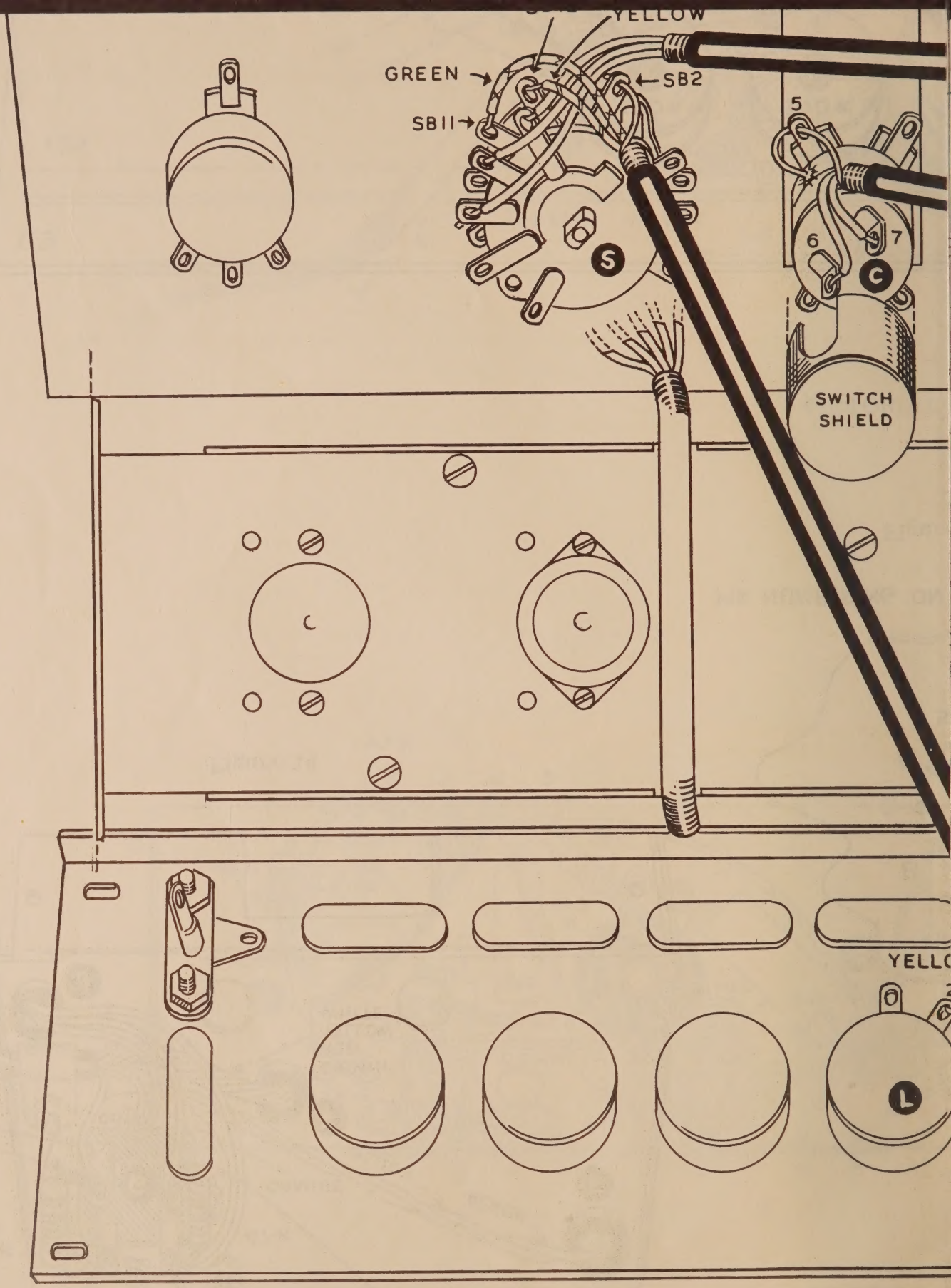


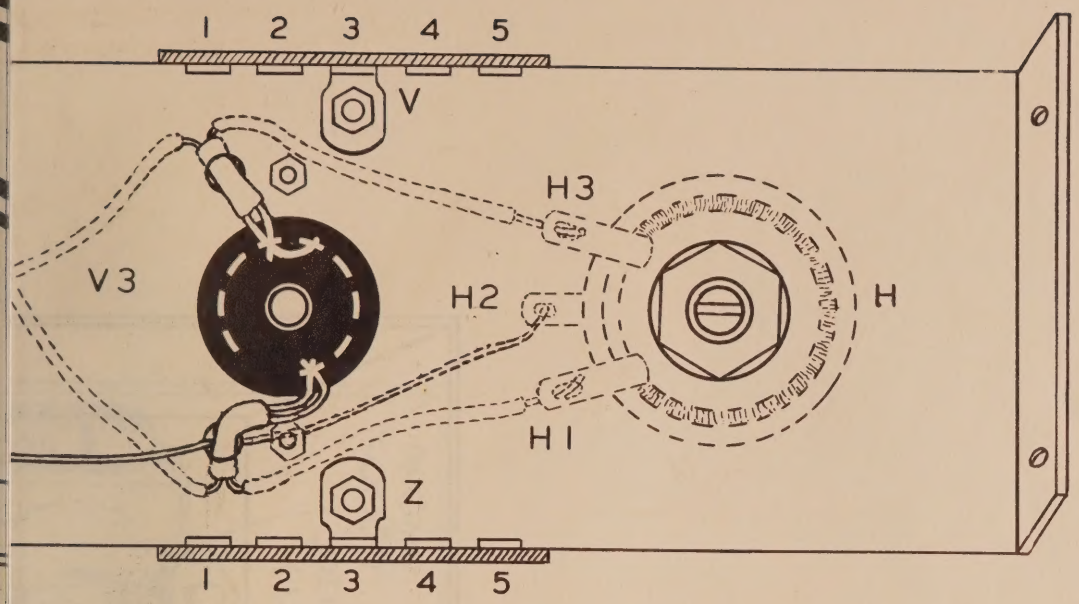

PICTORIAL F



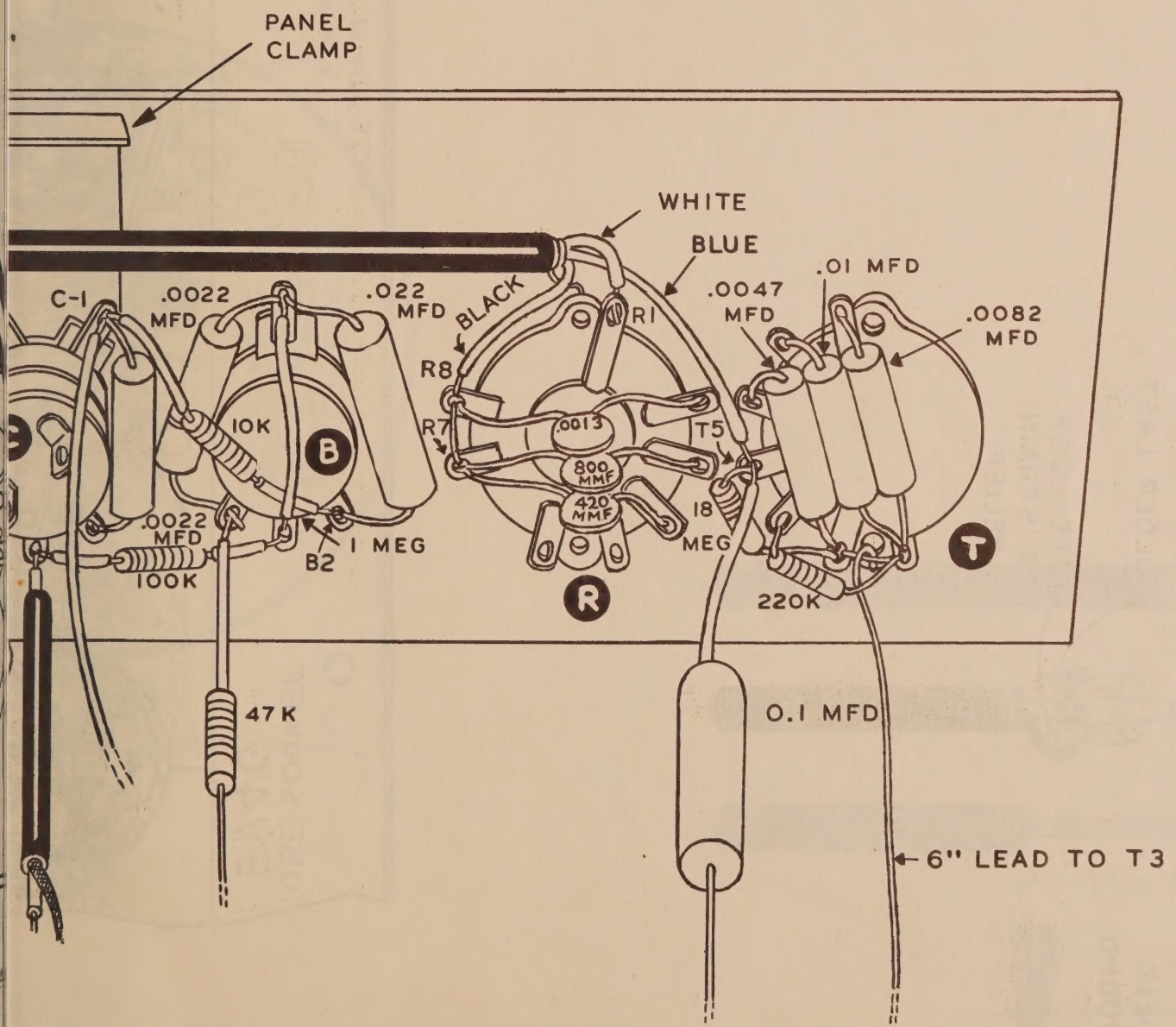

PICTORIAL G




PICTORI


1 2 3 4 5
V
H3
V3
H2
H
H1
Z
1 2 3 4 5

IAL B


PANEL CLAMP
WHITE
BLUE
C-1
.0022 MFD
.022 MFD
BLACK
R1
.0047 MFD
.01 MFD
.0082 MFD
R8
R7
10K
B
.0013
T5
800 MMF
420 MMF
18 MEG
.0022 MFD
100K
B2
1 MEG
R
T
220K
47K
0.1 MFD
6" LEAD TO T3

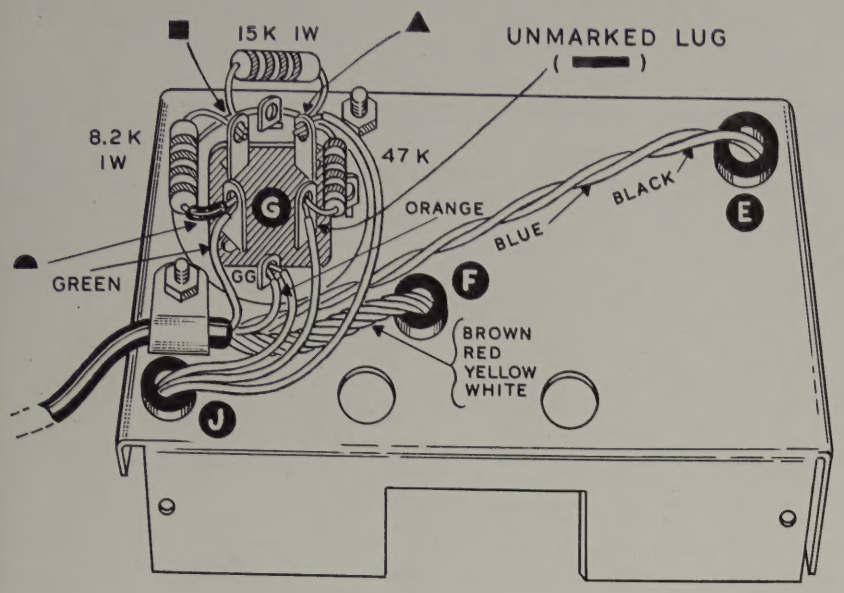
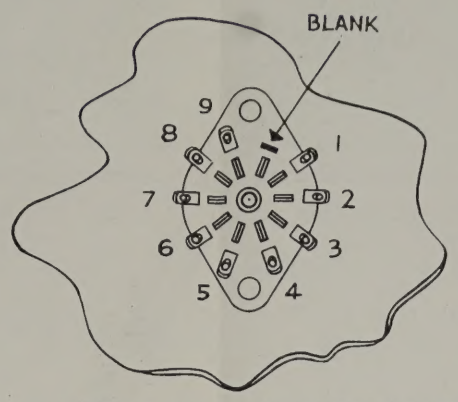



Figure 14




PIN NUMBERING ON NOVAL TUBE SOCKET

Figure 16

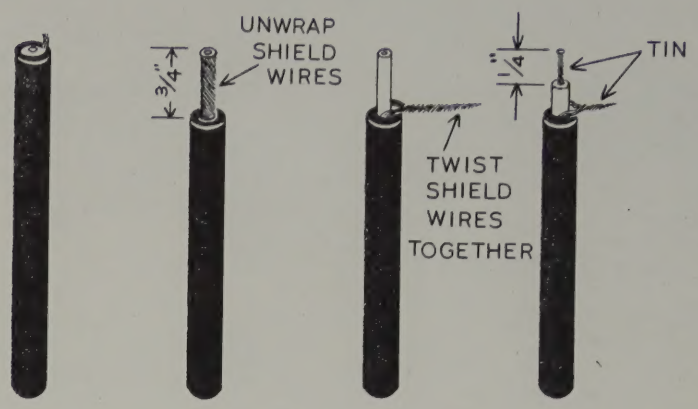
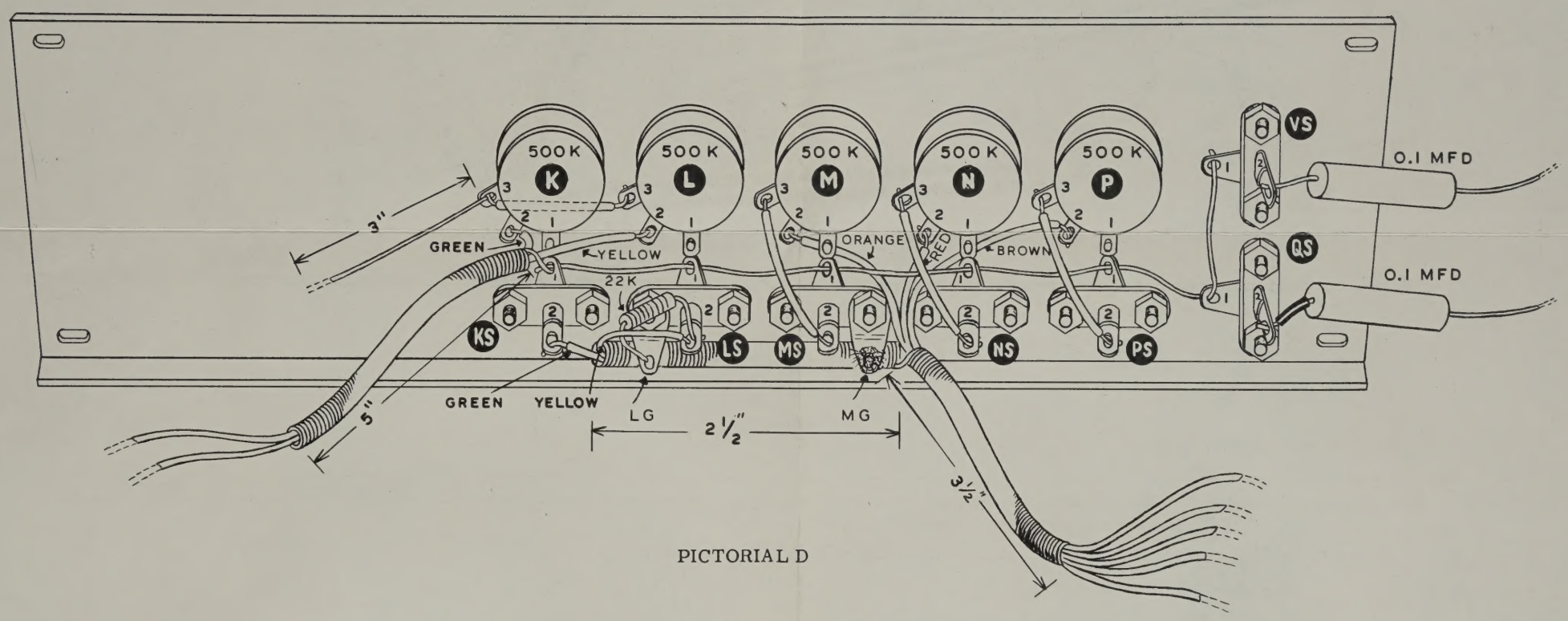
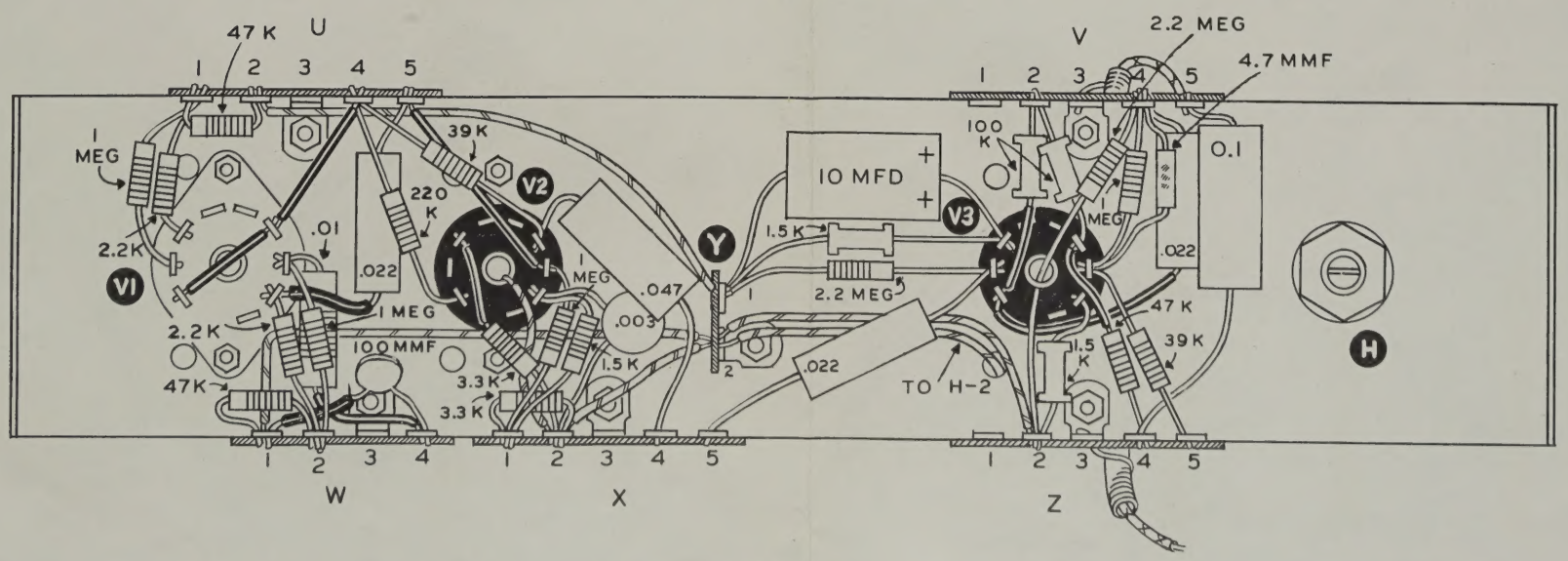


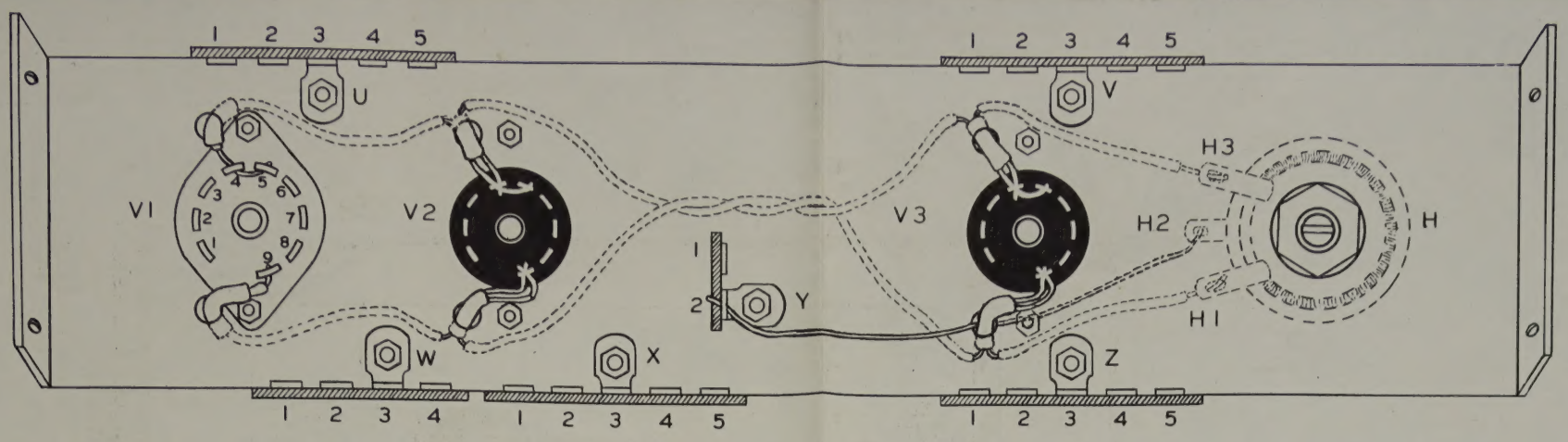

Figure 8



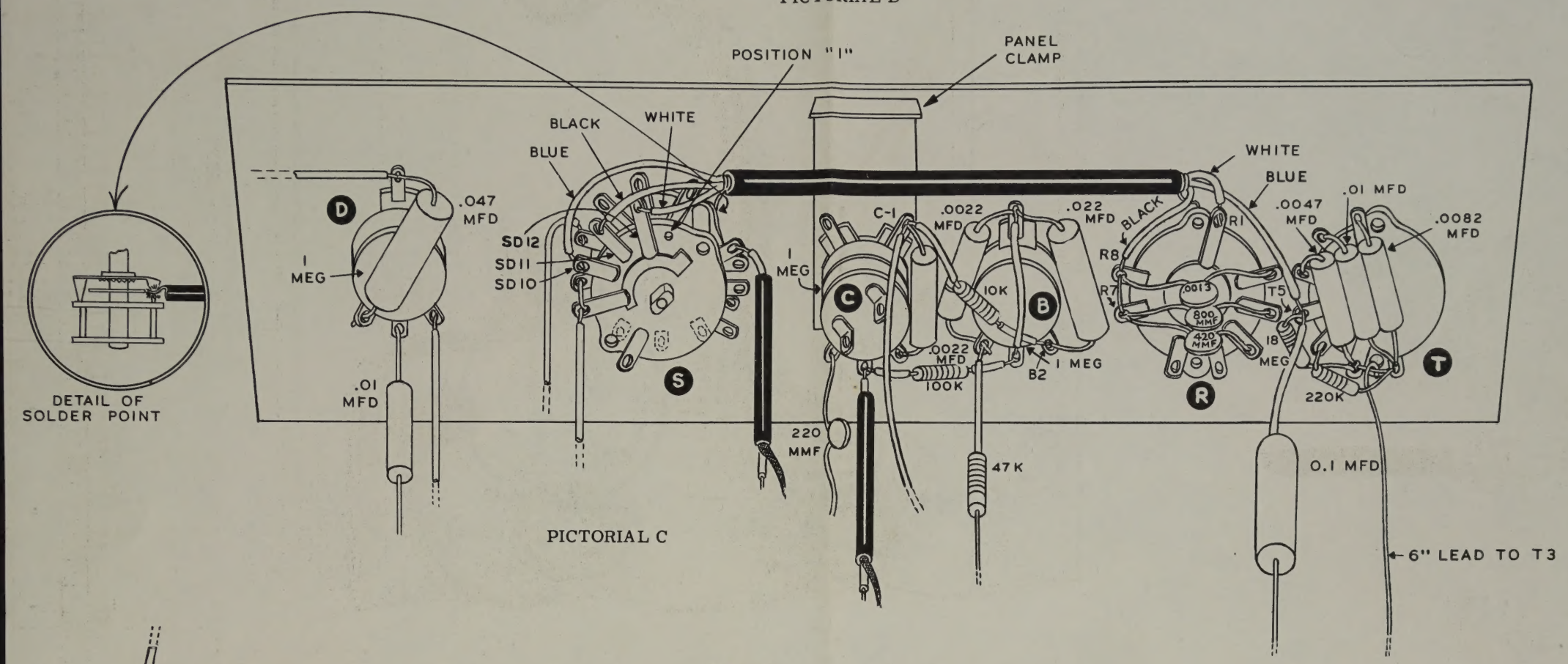

PICTORIAL D




PICTORIAL E




PICTORIAL B




PICTORIAL C

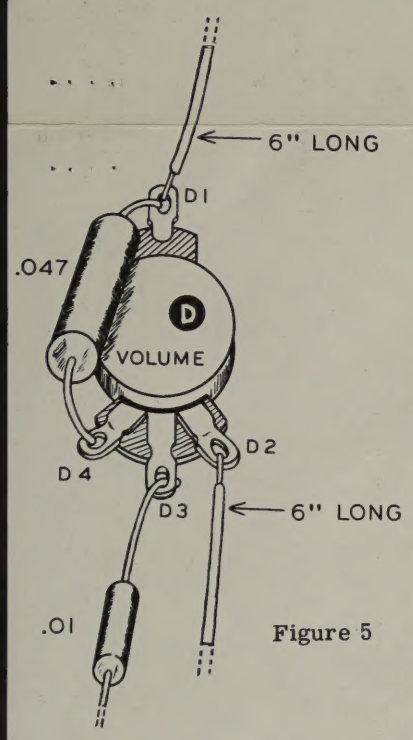



Figure 5

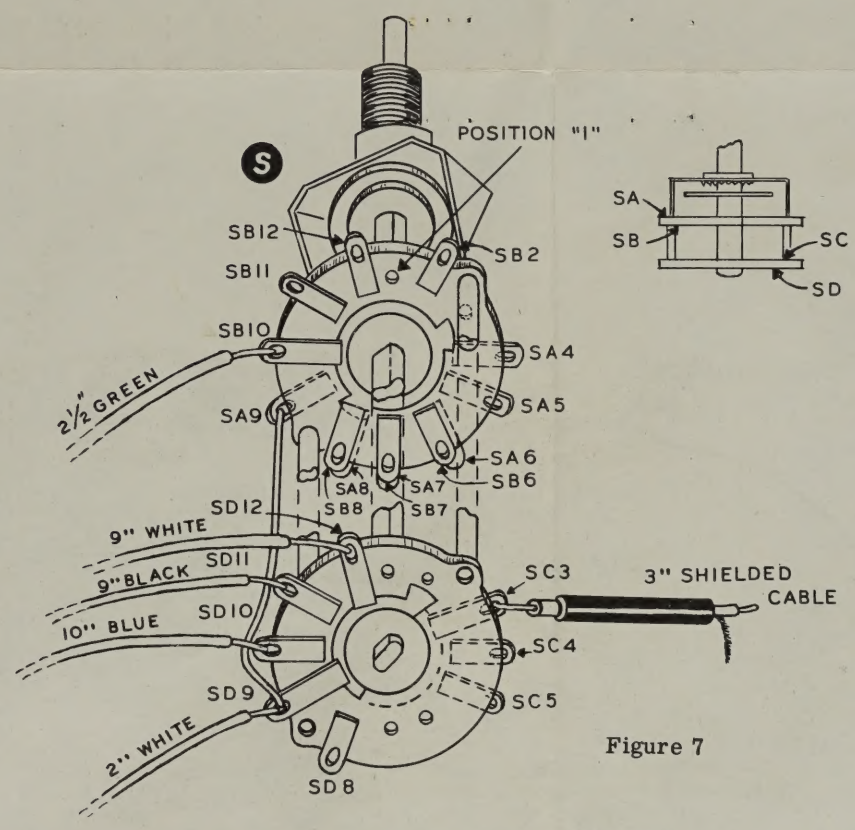



Figure 7

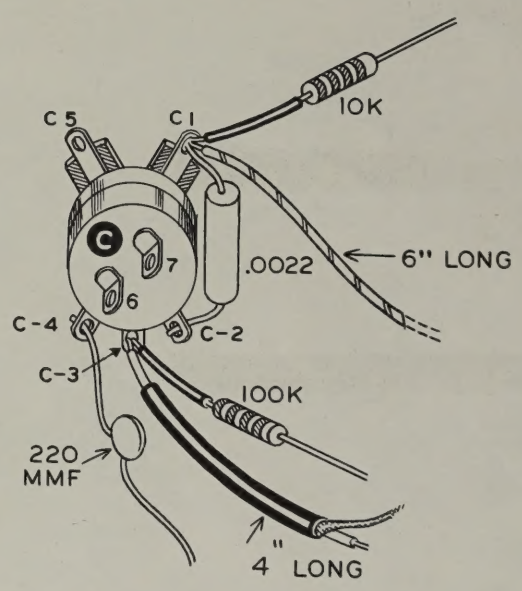



Figure 9

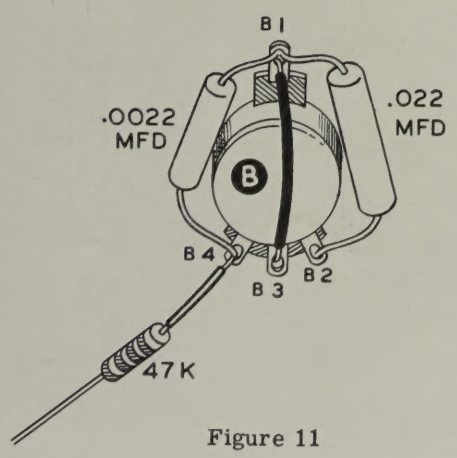



Figure 11

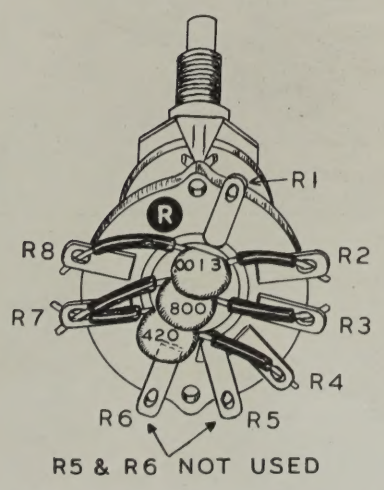



Figure 12

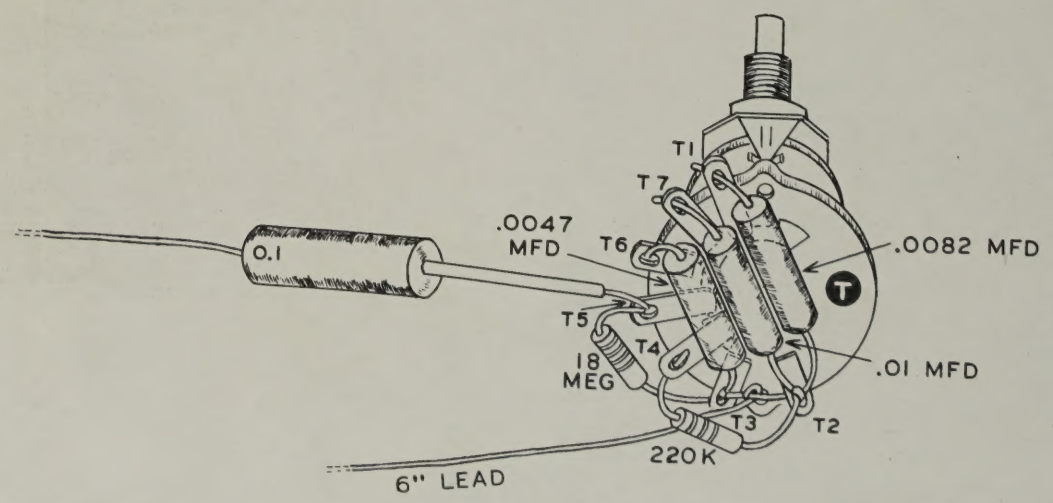
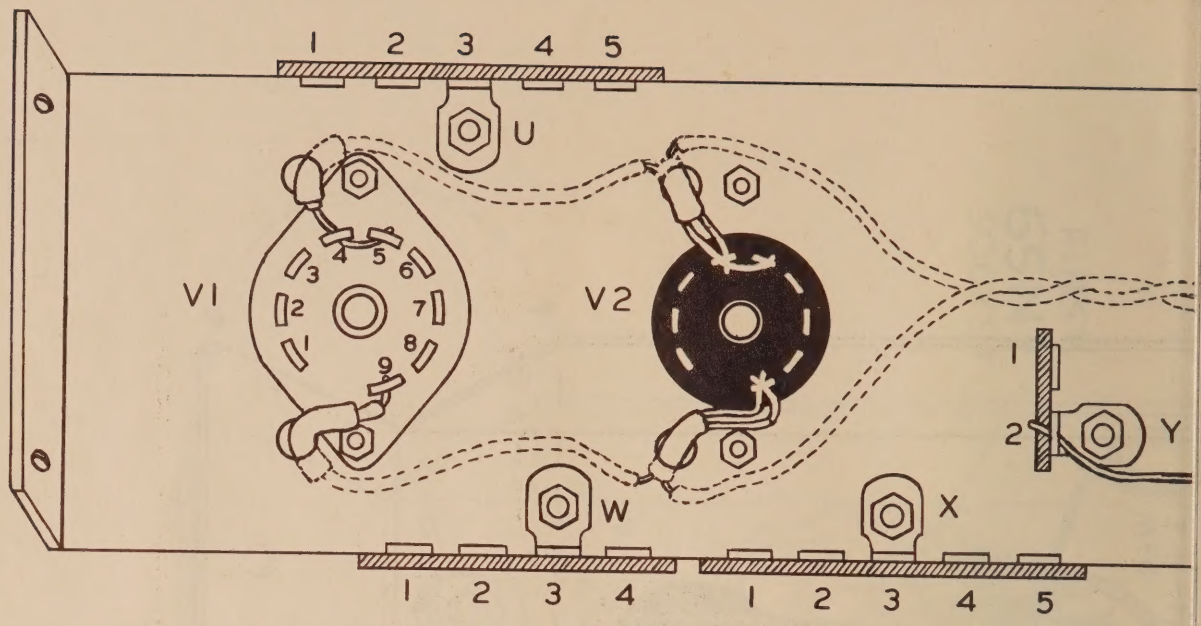
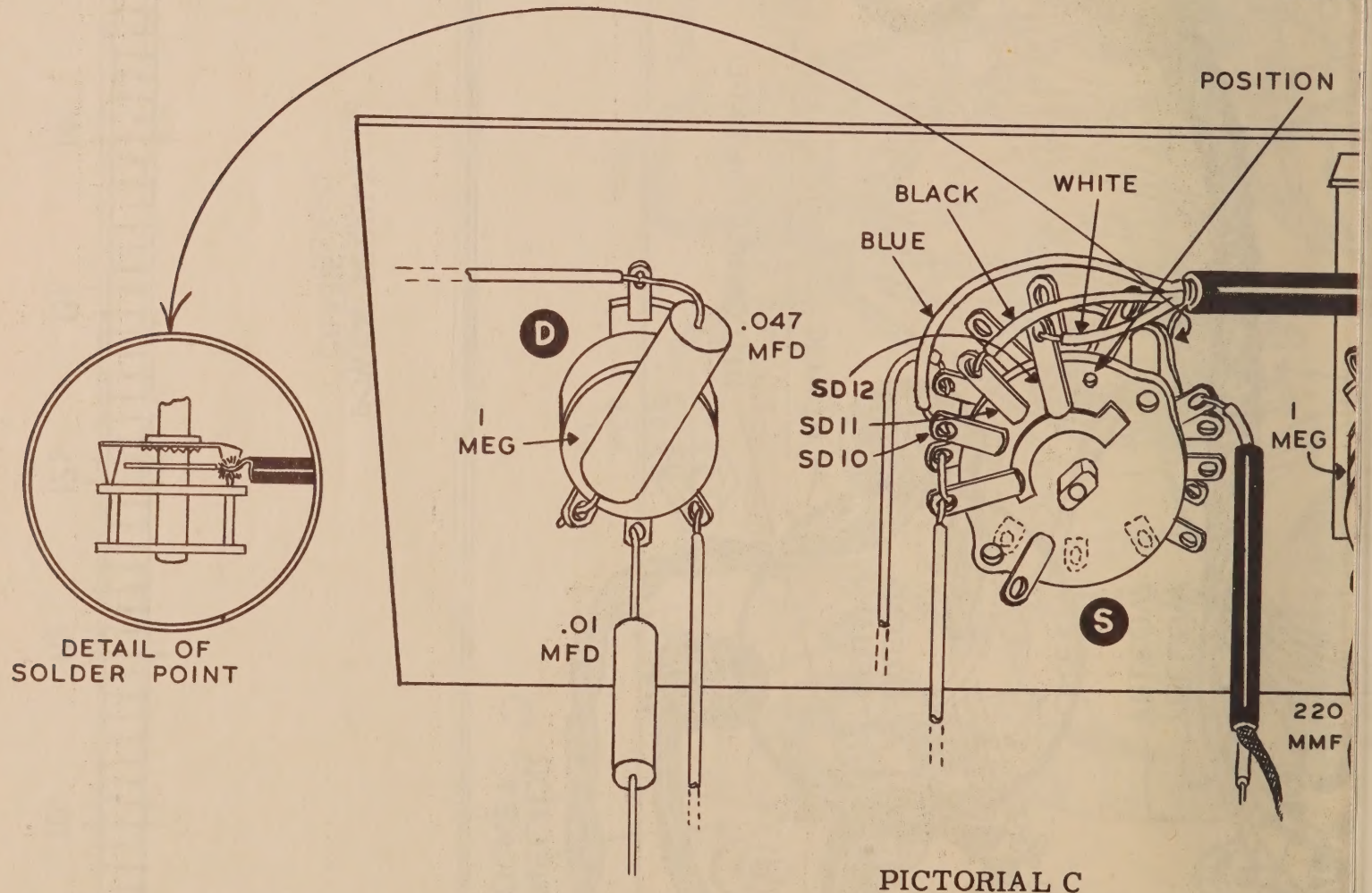



Figure 13




PICT




PICTORIAL C

# ASSEMBLY AND OPERATION OF THE HEATHKIT PREAMPLIFIER

## MODEL WA-P2


### SPECIFICATIONS

INPUTS:

Three high-level and two low-level inputs; individual level controls for each.

High-level inputs, 1, 2 and TUNER, for 0.1 volts or higher; 0.5 megohm input impedance.

Low-level inputs, PHONO and MIC, for 0.1 volts or lower; phono input impedance normally 22 KΩ for magnetic phono pickup; microphone input impedance 2.2 megohms.

OUTPUTS:

Two: Output to main amplifier variable 0 to at least 2.5 volts RMS from any normal program source; full control of input selection, volume, phono compensation and tone balance, cathode follower output; recommended load impedance 200 KΩ or higher shunted by .007 μfd or less; up to 100 feet of shielded microphone cable, or up to 200 feet of RG-58-AU coaxial cable, may be used between preamplifier and main amplifier with not more than 3 db loss at 10,000 cps.

Output to recorder input providing minimum of 0.25 volts RMS from any normal program source; full control of input selection, phono compensation and individual input level, but independent of volume control or tone controls; cathode follower output with same characteristics as output to main amplifier input.

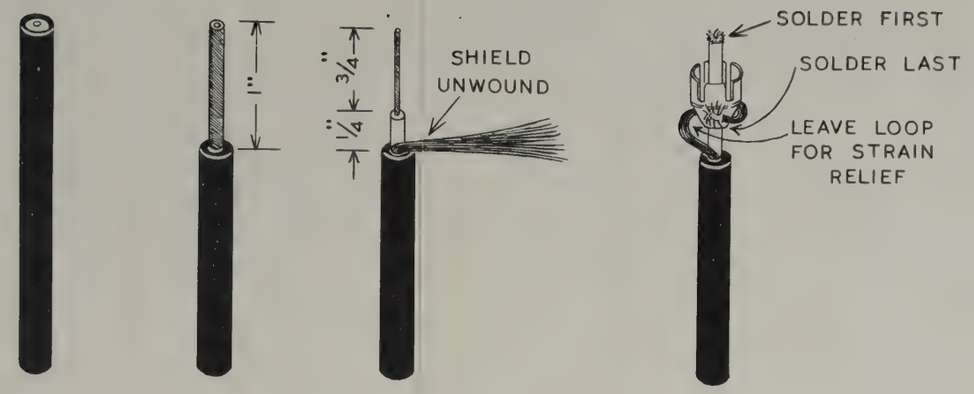
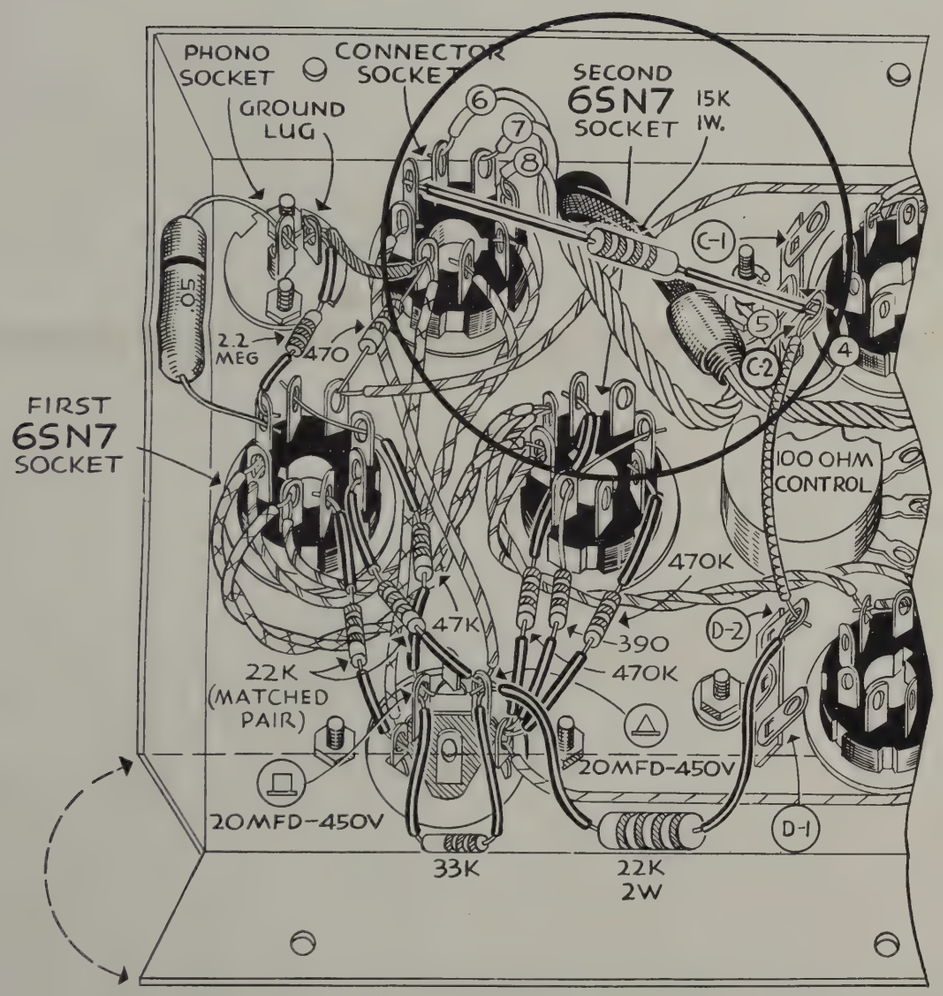
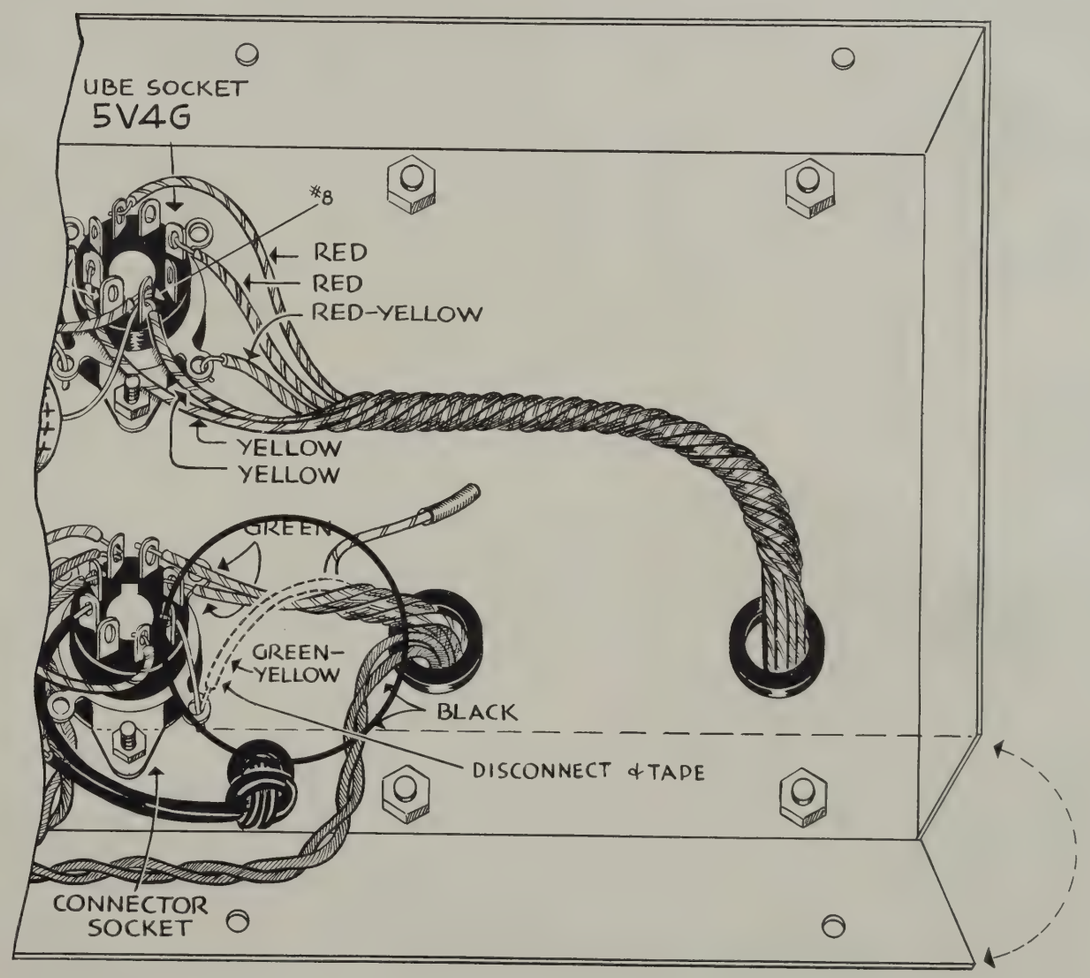



Figure 19

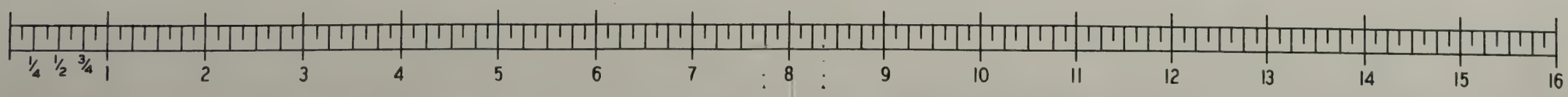



MAIN AMPLIFIER
CHASIS




POWER SUPPLY
CHASIS

PICTORIAL H



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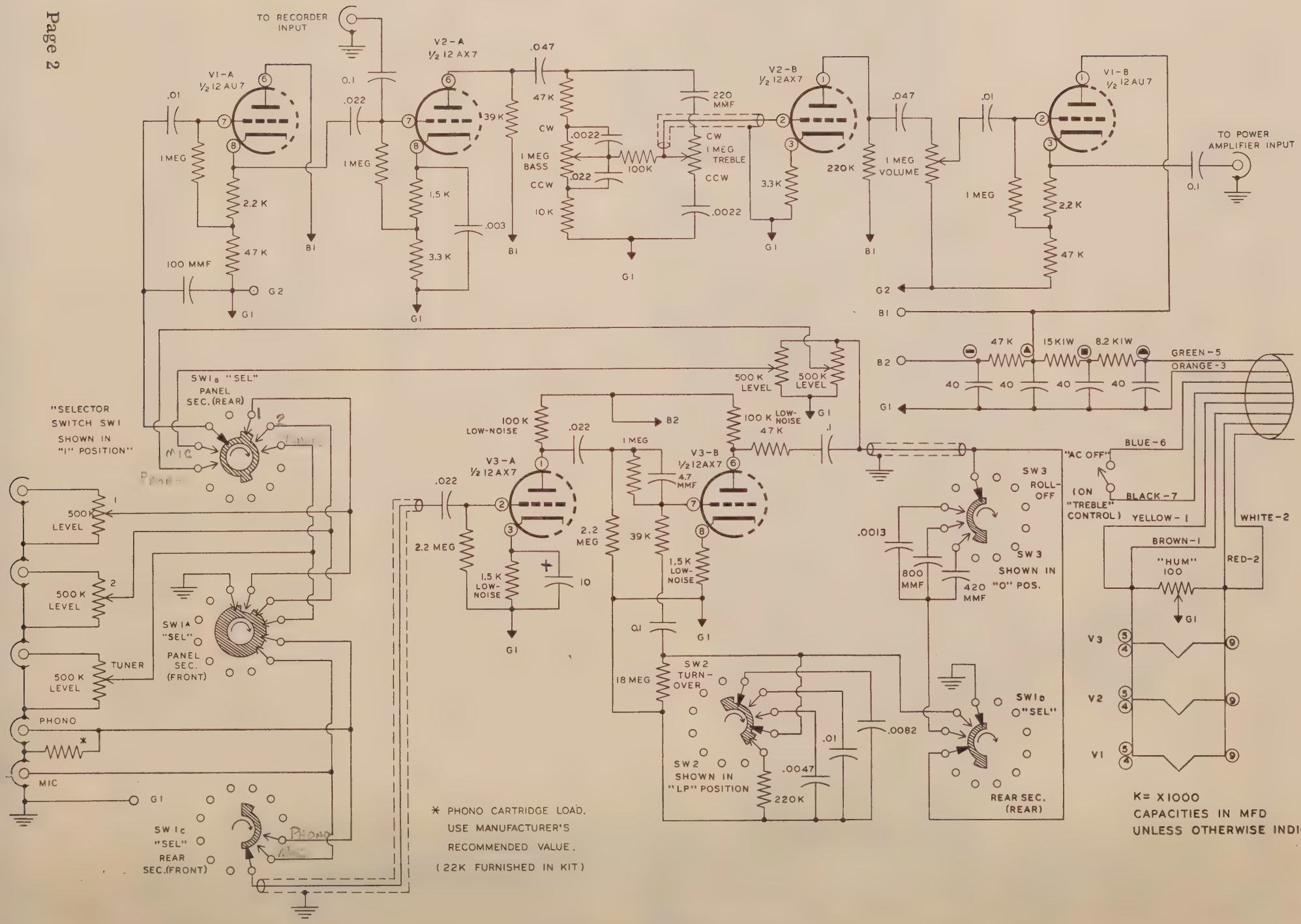
Output to recorder input providing minimum of 0.25 volts RMS from any normal program source; full control of input selection, phono compensation and individual input level, but independent of volume control or tone controls; cathode follower output with same characteristics as output to main amplifier input.




* PHONO CARTRIDGE LOAD. USE MANUFACTURER'S RECOMMENDED VALUE. (22K FURNISHED IN KIT)

K= X1000
CAPACITIES IN MFD
UNLESS OTHERWISE INDICATED

GAIN:

High-level inputs:

| | | | |
|---|---|---|---|
| 0.05 | volt input | produces 0.5 | volt RMS output |
| 0.09 | " | 1.0 | " |
| 0.14 | " | 1.5 | " |
| 0.18 | " | 2.0 | " |
| 0.23 | " | 2.5 | " |

Low-level inputs:

| | | | |
|---|---|---|---|
| 1.4 | millivolts input | produces 0.5 | volt RMS output |
| 2.5 | " | 1.0 | " |
| 3.6 | " | 1.5 | " |
| 4.9 | " | 2.0 | " |
| 6.2 | " | 2.5 | " |

Measurements made at 1000 cps with LEVEL and VOLUME controls set for maximum gain.

FREQUENCY RESPONSE:

1.0 db from 25 cps to 30,000 cps
1.5 db from 15 cps to 35,000 cps

Measurements made through MIC input, tone controls set for flat response at 100, 1000 and 10,000 cps. (See Figure 2.)

HARMONIC DISTORTION:

At 2.5 volts RMS output, total measured harmonic distortion (not corrected for source distortion) is:

| Input | 20 cps | 1000 cps | 10,000 cps | 20,000 cps |
|---|---|---|---|---|
| 0.5 v at TUNER | 0.63% | 0.17% | 0.33% | 0.47% |
| 6 mv at PHONO | 1.15% | 0.46% | 0.54% | 0.66% |
| 15 mv at MIC | 0.35% | 0.26% | 0.42% | 0.48% |
| Source distortion from generator | 0.74% | 0.22% | 0.22% | 0.24% |

NOTE: Where source distortion is greater than measured distortion, it is assumed that certain cancellation effects are responsible.

INTERMODULATION DISTORTION:

Measured at 60 and 7000 cps with 4:1 ratio; tone controls at flat, volume at maximum, output level controlled by adjusting LEVEL control.

| Output Voltage (RMS) | MIC Input | TUNER Input |
|---|---|---|
| 0.5 | 0.48% | 0.2% |
| 1.0 | 0.50 | 0.3 |
| 1.5 | 0.50 | 0.4 |
| 2.0 | 0.55 | 0.59 |
| 3.0 | 0.70 | 0.77 |
| 4.0 | 0.88 | 0.98 |
| 5.0 | 1.1 | 1.2 |

HUM AND NOISE:

| | |
|---|---|
| 0.5 volt at TUNER input | 72 db below 2.5 volts RMS |
| 6 mv at PHONO input | 62 db below 2.5 volts RMS |
| 15 mv at MIC input | 70 db below 2.5 volts RMS |

Measured with tone controls set for flat response at 100, 1000 and 10,000 cps; volume control at maximum gain; turnover control at LP; rolloff control at 0; power cord polarized

for minimum hum; hum balance control set for minimum hum in PHONO input position; LEVEL control adjusted for 2.5 volts RMS output at input voltage shown.

PHONOGRAPH:

COMPENSATION: Low-frequency compensation provided by four-position TURNOVER control. See Figure 1 for curves.

High-frequency compensation provided by four-position ROLLOFF control. See Figure 1 for curves.

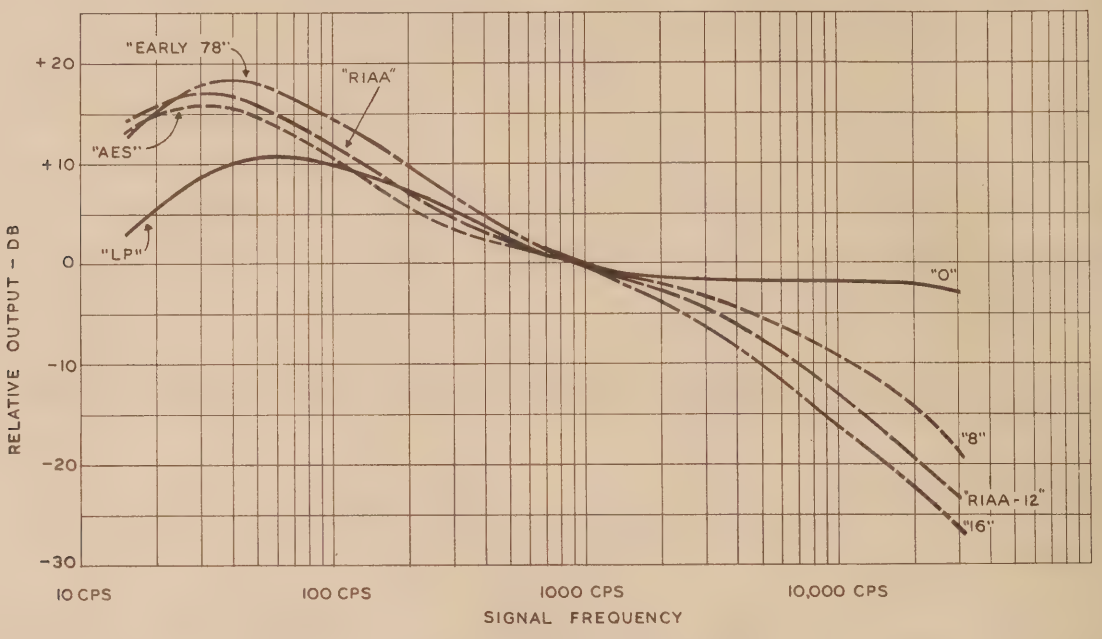



Figure 1

PHONOGRAPH EQUALIZER CURVES

(TURNOVER CURVES TAKEN WITH ROLLOFF SET AT 0)

(ROLLOFF CURVES TAKEN WITH TURNOVER SET AT LP)

TONE CONTROL:

Separate bass and treble tone controls. Bass control provides approximately 18 db boost and 12 db cut at 50 cps. Treble control provides approximately 15DB boost and 20 db cut at 15,000 cps. See Figure 2 for curves.

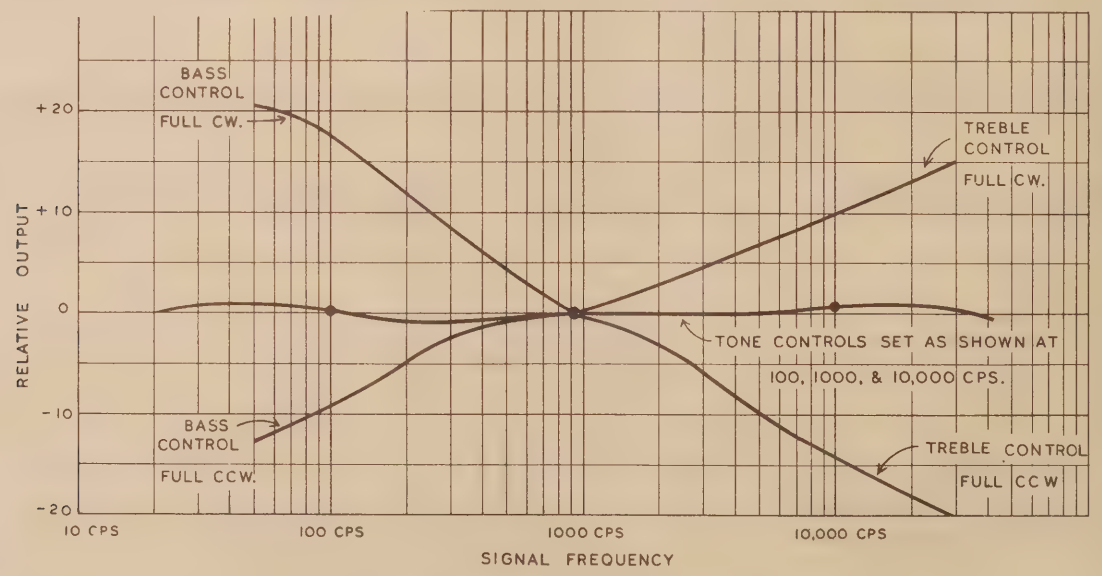



Figure 2

FREQUENCY RESPONSE AND TONE CONTROL CURVES

(BASS CURVES TAKEN WITH TREBLE CONTROL AT FLAT)

(TREBLE CURVES TAKEN WITH BASS CONTROL AT FLAT)

VOLUME CONTROL:

Conventional uncompensated voltage divider type at grid of main amplifier cathode follower output stage. Space is provided to mount a "loudness control" where program source outputs and main amplifier sensitivity permits. See Figure 3 for futher information.

INPUT SENSITIVITY FOR "MIC" AND "PHONO" INPUTS OF HEATHKIT WA-P2 PREAMPLIFIER.

Curve marked "MIC INPUT (VOLUME CONTROL)" represents input-output characteristic for WA-P2 Preamplifier with conventional volume control through "MIC" channel.

Curve marked "PHONO INPUT (VOLUME CONTROL)" same as above except for "PHONO" channel.

Curve marked "PHONO INPUT (LOUDNESS CONTROL)" represents input-output characteristic when using loudness control in place of conventional volume control, through "PHONO" channel.

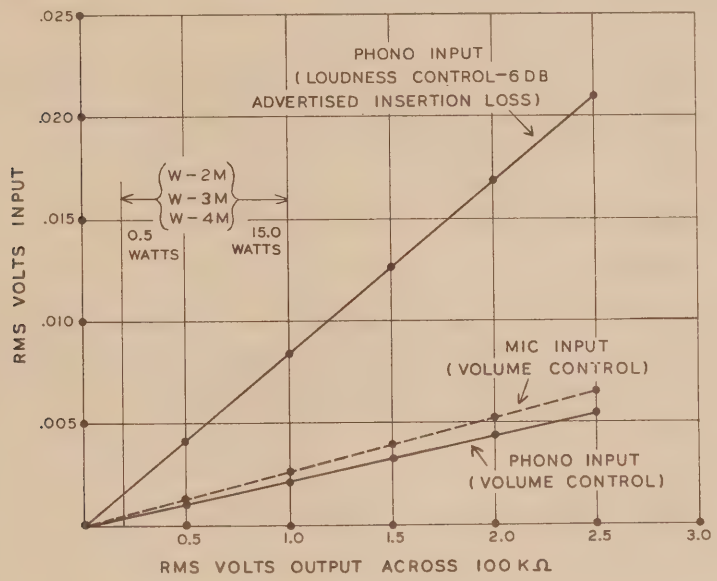



Figure 3

1. VOLUME OR LOUDNESS CONTROL AT FULL CLOCKWISE.
2. TONE CONTROLS SET AT FLAT.
3. TURNOVER CONTROL AT "LP."
4. ROLLOFF CONTROL AT "0."
5. LEVEL CONTROL FULL CLOCKWISE.
6. 1 KC SIGNAL.

To Use This Chart: From the manufacturer's specifications, determine the input voltage required to drive your power amplifier to rated output. At this point along the horizontal axis, marked "RMS VOLTS OUTPUT ACROSS 100 KΩ", draw a vertical line intersecting the three curves of the graph. Using the applicable curve, project this point of intersection to the left-hand vertical axis. Any input source furnishing a signal greater than this value is capable of driving the main amplifier to rated output when the WA-P2 is used as a preamplifier.

For Example: You have a Heathkit Williamson-type main amplifier, model W-2M. You wish to know if you can use the WA-P2 with conventional volume control, working out of a Fairchild 215 phonograph pickup. From the manufacturer's specifications, you determine that 0.75 volts input will drive the W-2M to 5 watts output. At this point, a vertical line intersects the PHONO INPUT (VOLUME CONTROL) curve at a value of approximately 0.002 volts input. From the manufacturer's data, the Fairchild 215 cartridge delivers 3 millivolts (0.003 volts) at 7.5 cm/sec. Since this value is greater than the required input, you are assured that the combination is satisfactory.

LEVEL CONTROLS:

Individual controls for each input to permit adjustment of level thus preventing overloading of input circuits. Input levels may be set so no volume adjustments need be made when selector switch is operated.

POWER SUPPLY:

Requires power from external source, as follows:

6.3 v AC at 1.0 amp.
300 v DC at 10 ma.

These voltages are available from any Heathkit Williamson-Type amplifier, models WA-1, W-2M, W-3M or W-4M. One additional resistor is required; this resistor is supplied with the WA-P2 kit. An eight-conductor cable terminating in an octal plug is supplied with the kit. This plug makes all required power connections to Heathkit main amplifiers.

POWER SWITCHING:

AC on-off switch on treble tone control, rated at 3 amperes, 125 volt AC. Switch leads are brought out through eight-conductor power cable.

DIMENSIONS:

| | |
|---|---|
| Cabinet only: | 12 9/16" long, 3 3/8" high, 4 7/8" deep. |
| Overall: | 12 9/16" long, 3 5/8" high, 5 7/8" deep. |

WEIGHT:

| | |
|---|---|
| Net weight: | 3 1/2 pounds |
| Shipping weight: | 7 pounds |

NOTE: The measurements given above were taken on a representative preamplifier. Variations from these measurements are to be expected because of normal production deviations in components, lead placement during wiring and similar changes. Unless otherwise stated, the following settings were maintained during test:

Volume control full on
Tone controls set for flat response at 100, 1000 and 10,000 cps
Turnover control set at LP
Rolloff control set at 0
Level controls adjusted for output voltage indicated:
2.5 volts RMS at 1000 cps if not otherwise stated

Output measurements were taken at the end of a four-foot length of shielded cable, with a capacity of 55 $\mu\mu$f per foot. Power supply was taken from a W-2M Heathkit Williamson-type Amplifier, modified in accordance with the instruction manual and operated at 117 volts 60 cycles.

## INTRODUCTION

The Heathkit model WA-P2 was designed to fulfill the performance requirements of the most critical audiophile, at the lowest possible cost. It is truly a worthy companion for the Heathkit Williamson-type main amplifiers with which it was designed to be used. Where sufficient filament and plate power is available, it may also be used to great advantage with any other true high-fidelity amplifier.

To our knowledge, the WA-P2 meets or exceeds the specifications for preamplifiers for the most rigorous high-fidelity applications. It will do justice to the finest available program sources whether they be phonograph pickups, tuners, microphones or recorders. But no preamplifier can correct for serious distortion in the following power amplifier or reproducer system. It can only deliver to these units program material conveniently selected, properly compensated and free of contributed distortion or extraneous noise. When constructed and adjusted in accordance with instructions, the WA-P2 is fully capable of meeting these requirements.

## CIRCUIT DESCRIPTION

In addition to the data presented in the specifications, the following brief circuit description may be of interest to the technically inclined constructor.

High-level inputs are adjusted to equal and suitable volume levels by the LEVEL controls. The desired input is selected by means of the back contacts of the first wafer of the selector switch. Low-level inputs are selected by the front contacts of the second wafer of the selector switch. (Idle input channels are grounded through the front contacts of the first wafer.) Low-level signals are fed through triode V-3A and passed to the grid of triode V-3B through the .022 coupling condenser and the 1 megohm series resistor, by-passed by the 4.7 $\mu\mu$f condenser. When the input switch is in the PHONO position, signal voltage is also fed through the 39 K$\Omega$ resistor and the 0.1 $\mu$fd coupling condenser to the TURNOVER control switch and to ground through the back contacts of the second wafer of the selector switch. This shunt network produces the rising low-frequency characteristics required for proper equalization of phonograph recordings. Variations of this response curve are controlled by the condenser-resistor combinations selected by the turnover control. In the MIC input position, the entire TURNOVER control is shorted to ground.

Audio voltages appearing at the plate of V3-B are fed through the 47 K$\Omega$ resistor and the .01 $\mu$fd condenser to the paralleled low-level LEVEL controls. When the PHONO input is selected, the back contacts of the second wafer connect the ROLLOFF control between this point and ground. Rotation of the rolloff control connects increasingly larger shunt capacities to ground, thus de-emphasizing the higher frequencies, as shown in the equalization curves. In the MIC input position, the ground return is broken so that the rolloff control is deactivated.

The adjusted outputs from the PHONO and MIC level controls appear at the back of the first wafer of the selector switch at the same approximate level as the high-level inputs.

Audio voltage from the selected source is fed to the cathode follower stage V1-A and appears at a much lower impedance at the recorder input jack. As explained in the specifications, this permits the use of long interconnecting cables without loss of high frequencies. This voltage is also applied to the grid of V2-A, amplified, and fed into the tone control circuits. The signal voltage is then reamplified in triode V2-B. Volume control is accomplished between the plate circuit of this stage and the grid of V1-B, a conventional cathode follower triode with the characteristics outlined previously under SPECIFICATIONS.

Plate supply voltages are developed at the output of the three-section RC filter whose parameters have been established for maximum rejection of very low frequencies as well as reduction in 60 and 120 cycle ripple. This filter system provides a high degree of decoupling and so stabilizes the performance of the preamplifier when powered from a following main amplifier where plate supply coupling might cause motor-boating.

Filament supply is line-frequency AC obtained from an external filament winding. No ground to any portion of the filament winding is used except through the hum-balance control in the preamplifier. By this means, a very substantial reduction in hum level is accomplished.

A great deal of experimentation resulted in the system of shielding and grounding used in the WA-P2 preamplifier. Use of large diameter spiraled conduit reduces the shunting effect of shields at higher audio frequencies. All current-carrying grounds for a particular stage are returned to a common insulated point and individual ground leads are brought to chassis ground near the physical center of the chassis. In this way, chassis currents are reduced to a minimum and coupling in ground returns becomes a minor problem.

## NOTES ON ASSEMBLY AND WIRING

Assembly and wiring of your preamplifier kit is not difficult. Every possible precaution has been taken to assist you in completing it. Please take the necessary time to read each step thoroughly before starting to perform the work. Work carefully, and you will be repaid by a real sense of accomplishment in addition to having acquired a truly fine piece of equipment.

Only a very small percentage of Heathkit assemblers experience any difficulty whatsoever in completing kits of this kind. The detailed instructions in this manual are specifically written with your problems in mind. We suggest that you take a few minutes now, before starting any construction, and read the entire manual. In this way, you will obtain a rough idea of the assembly process. The large fold-in pictorial diagrams are for your convenience and are quite helpful if attached to the wall above your work space. The diagrams are repeated in smaller form within the manual proper. We suggest that you retain the manual in your files for future reference in the use of the instrument and its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. DO NOT DISCARD ANY PACKING MATERIALS UNTIL THIS HAS BEEN DONE. By following this plan, the chance of accidentally throwing away some part will be eliminated. Full size sketches of each of the parts categories appear in Figure 22. Use this in checking against the parts list and in identifying any questionable component.

Components with wire pigtail leads can be conveniently sorted by inserting one of the leads into the corrugated edge of the shipping carton flap. It may be helpful to mark the value of the component on the flap so the part may be readily located when needed.

If some shortage is found in checking the parts, please notify us promptly and return the inspection slip with your letter to us. Hardware items are counted by weight; an occasional shortage occurs and if this is true in your kit, please obtain the missing parts locally if at all possible.

Resistors and controls generally have a tolerance rating of ±20% unless otherwise stated in the parts list. Therefore, a 100 KΩ resistor may test anywhere from 80 KΩ to 120 KΩ and still be acceptable. Tolerances on electrolytic condensers may be even wider and commonly run from +100% to -50%. The parts furnished with your Heathkit have been specified so as to meet the performance specifications given.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are very carefully checked before they are approved and the parts supplied will work satisfactorily in your kit. For example, if your kit is short a 2.2 megohm resistor, and a 2 megohm resistor is furnished which is not on the parts list, you will understand that such a substitution has been made. This fact is mentioned here only to prevent any confusion in checking the contents of the kit.

CAUTION:
We strongly urge that you follow the wiring and parts layout shown in this manual. The position of leads and parts is quite critical in the instrument and changes may seriously affect the characteristics of the circuit. We do not represent that the circuit or layout of the instrument cannot be improved; however the methods shown in this manual are the result of many experimental models and unless the constructor has access to full laboratory facilities, we recommend that they be followed very closely.

## NOTES ON WIRING

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

Read the notes on the inside rear cover concerning wiring and soldering.

In Pictorial B, note that each component part has been given a code designation. In addition, each terminal has also been assigned a number.

When the wiring instructions read, "Connect one end of a 3.3 KΩ resistor to V2-3 (S)," it will be understood that the connection is to be made to pin 3 of tube socket V2. The abbreviation (S) indicates that the connection should be soldered. In some cases, more than one lead is connected to the same terminal. The terminal should not be soldered until the last lead is connected and the abbreviation (NS) is used to indicate this.

Unless otherwise indicated, all wire used is insulated. Wherever there is a possibility of the bare leads on resistors and condensers shorting to other parts or to chassis, the leads should be covered with insulated sleeving. This is indicated in the instructions by the abbreviation (Ins.).

In some cases, leads are quite short and yet must be insulated. It is convenient to use bare wire for such connections, adding sleeving where required. This is indicated in the instructions by the phrase, "Use bare wire and sleeving."

Leads on resistors, condensers and sub-assemblies are generally much longer than they need to be to make the indicated connections. In these cases, the excess leads should be cut to minimum length as the part or sub-assembly is wired in place. Not only does this make the wiring much neater but in many instances, the excessively long leads will actually interfere with proper operation of the preamplifier.

Space has been provided for you to check off each operation as it is completed. This is particularly important in wiring and it may prevent omissions or errors, especially where your work is interrupted frequently as the wiring progresses. Some kit builders also have found it helpful to mark each lead in colored pencil on the pictorial as it is added.

## STEP-BY-STEP ASSEMBLY INSTRUCTIONS

These instructions are presented in a simple, logical, step-by-step sequence to enable you to complete your preamplifier with the least possible confusion. Be sure to read each step all the way through before you start to do it. When the step is completed, check it off in the space provided ( ).

We suggest that you do the following before any work is started:

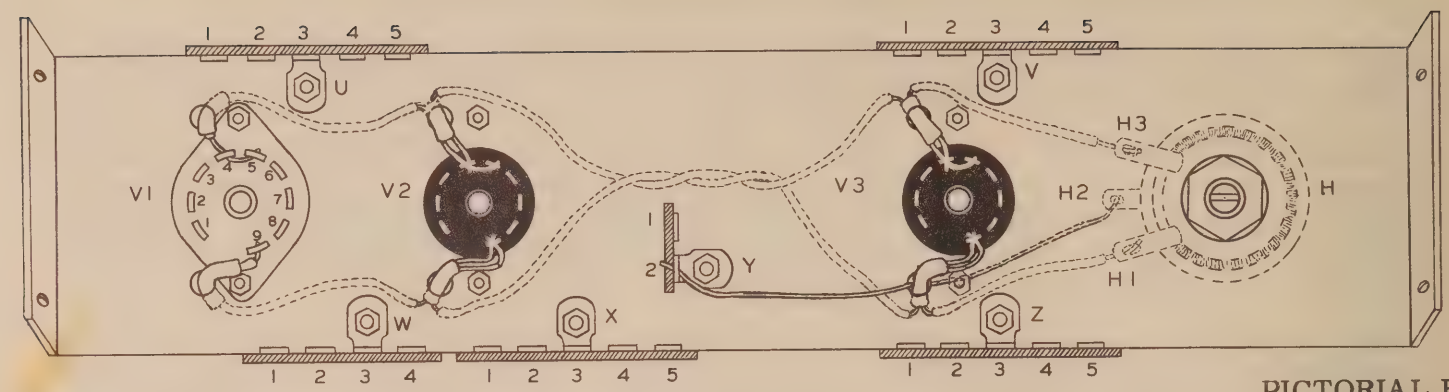
1. Attach the large fold-in pictorial diagrams to the wall above your work space.
2. Read through the entire assembly and wiring instructions. This is an excellent time to familiarize yourself with the general procedure followed.
3. Lay out all parts so that they are grouped in logical order. Refer to Figure 00 and the inside covers of this manual for assistance in identifying components.

The preamplifier is assembled and wired as four separate parts:

Front panel
Left-end bracket
Rear panel
Chassis

These sub-assemblies are then assembled and wired together. In this way, wiring is facilitated and it is possible to check each sub-assembly completely before further assembly or wiring can add confusion.

## CHASSIS SUB-ASSEMBLY




PICTORIAL B

( ) 1. Identify the chassis, the formed aluminum piece with four large holes down its center line. Place the chassis on your bench with the flanges at the end turned up and the two large holes to the left. Pictorial B will help you identify and orient the chassis properly.

( ) 2. Mount the wafer-type 9-pin socket at V1, using 3-48 machine screws (the smallest screws shipped with your kit) and nuts. No lockwashers need be used. Be sure the gap in the ring of contacts is placed as shown in Pictorial B. The socket wafer is mounted so the contacts extend toward you, in the same direction as the end flanges.

( ) 3. Mount one of the shielded 9-pin tube sockets at V2 using 3-48 hardware. This socket is inserted under the chassis, with the contacts passing through the hole. Again, orient the blank space as shown in Pictorial B.

( ) 4. Similarly, mount 9-pin tube socket V3.

( ) 5. Install the 100 Ω HUM control at H. Place a large lockwasher on the threaded bushing of the control, then the insulated shoulder washer. Pass the control shaft up through the hole at H, add the flat insulating washer, then a flat steel washer and finally a large hex nut. See Figure 4 for details.

( ) 6. Mount a 5-lug terminal strip at U. Use a short 6-32 machine screw. (The two long screws are used to mount the filter condenser.) Use a lockwasher under the hex nut and tighten securely. When properly mounted, the insulating strip will fall directly over the edge of the chassis.

( ) 7. In the same way, mount a 5-lug terminal strip at V.

( ) 8. Mount the 4-lug terminal strip at W.

( ) 9. Mount a 5-lug terminal strip at X.

( ) 10. Mount a 5-lug terminal strip at Z.

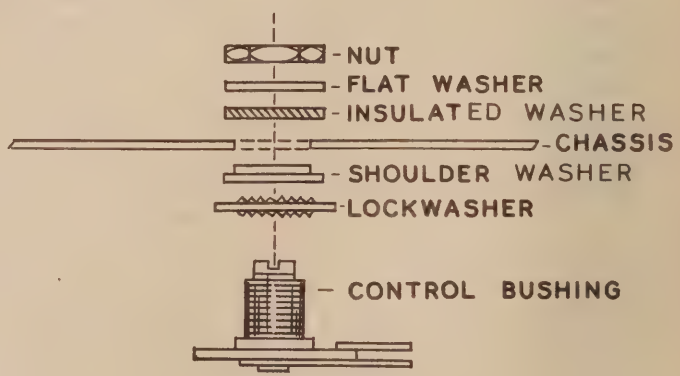



Figure 4

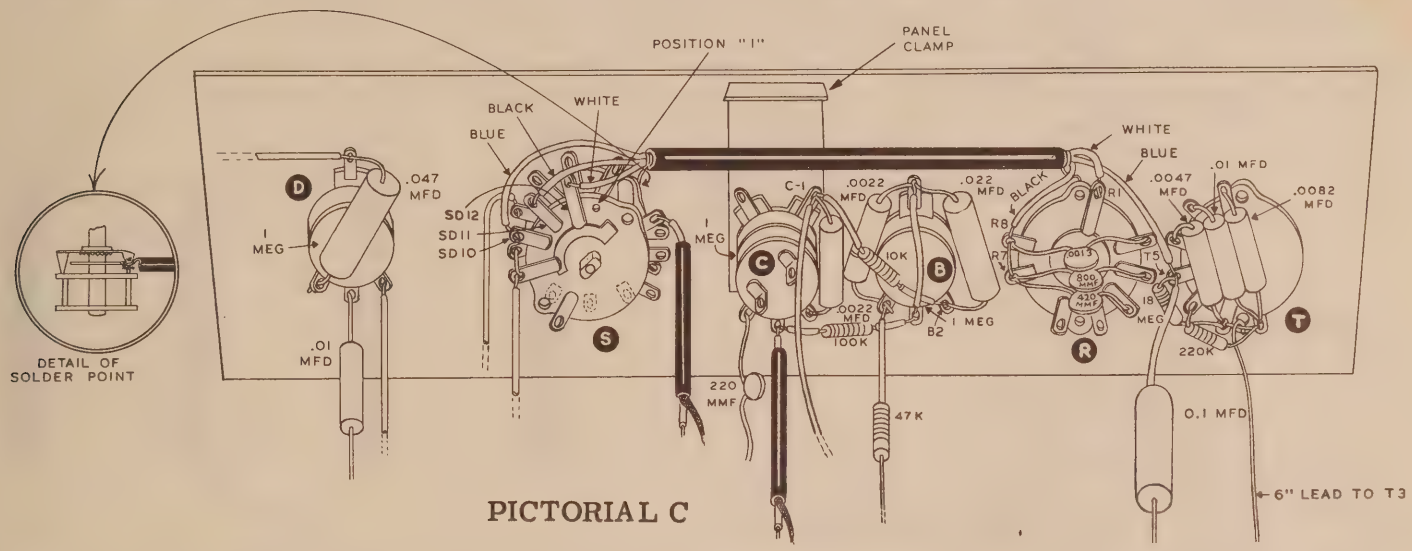
( ) 11. Mount the 2-lug terminal strip at Y, so that the insulated terminal is nearest the center of the chassis.

This completes the assembly of the chassis. Wiring instructions follow after assembly of the other parts of the preamplifier kit.

## CONTROL PANEL SUB-ASSEMBLY

Three controls and three wafer switches are mounted on the control panel. It is convenient to add certain components and wiring to these controls and switches before they are mounted on the panel. Pictorial C shows the completed panel sub-assembly. Before any soldering is done, refer to the instructions on wiring and soldering inside the back cover of this manual. Also, re-read the notes on Page 9 concerning wiring and soldering.

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.




PICTORIAL C

( ) 12. Figure 5 is a detail drawing of the VOLUME control D and its associated wiring. Slip one wire lead of a .047 μfd molded condenser through terminal D1 and the other lead through terminal D4. Pull the leads through until the body of the condenser is held snugly against the cover of the control. Crimp the leads to the terminals and cut off the excess wire. Now solder D4 (S). Do not solder D1 yet (NS).

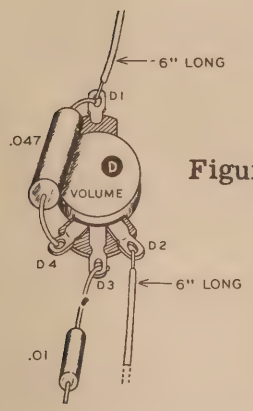



Figure 5

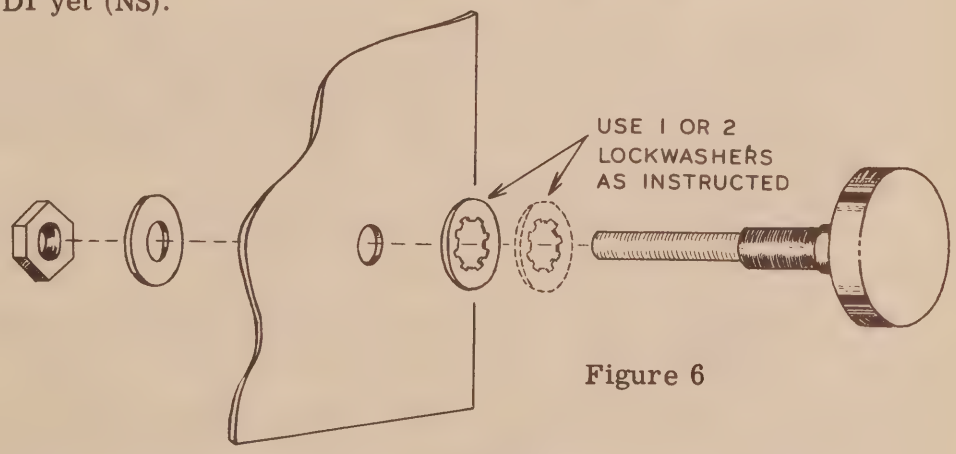



Figure 6

( ) 13. Cut one lead of a .01 μfd molded condenser to a length of 1" and in the same manner, connect it to D3 (S). Leave the other end free.

( ) 14. Connect one end of a 6" length of hookup wire to D1 (S). Leave the other end free.

( ) 15. Connect one end of a 6" length of hookup wire to D2 (S). Leave the other end free.

( ) 16. Mount the control on the back of the control panel in the left-hand hole, as shown in Pictorial C. Follow Figure 6 for method of assembly, using only one lockwasher. Do not tighten the nut at this time.

( ) 17. Refer to Figure 7 and identify the SELECTOR wafer switch, S. This is the 2-deck wafer switch. Inspect the switch carefully and note that there is one vacant position on the back. This position may be used for reference and will be referred to as #1. Other switch contacts will be numbered in clockwise sequence. Notice also that contacts appear on both sides of each of the two wafers. Letter designators will be used to identify the wafer and side:

SA - Panel section, front side
SB - Panel section, back side
SC - Rear section, front side
SD - Rear section, back side

Thus, SB12 will refer to contact 12 on the back side of the panel section. Figure 7 is a detailed drawing of the switch and its associated wiring.

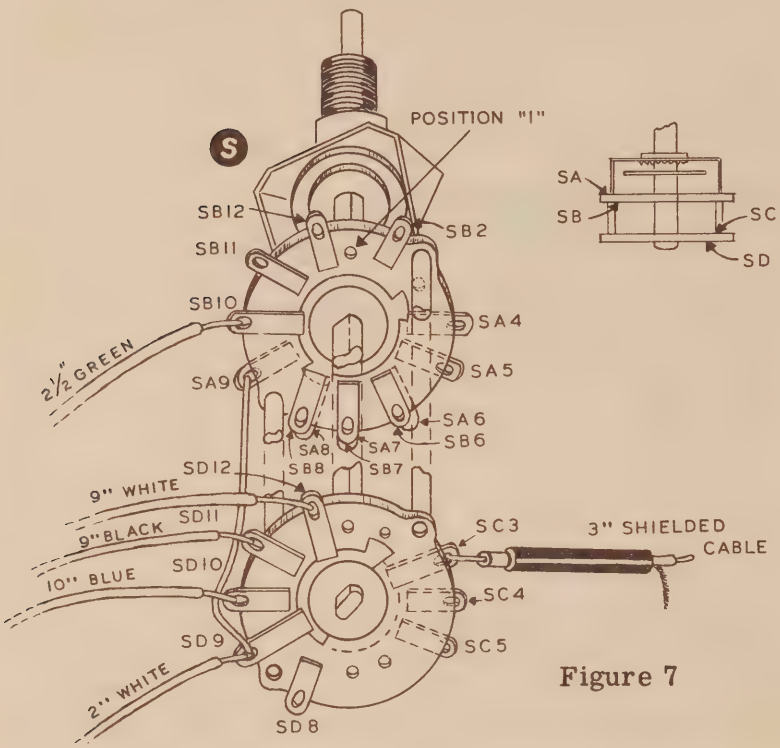



Figure 7

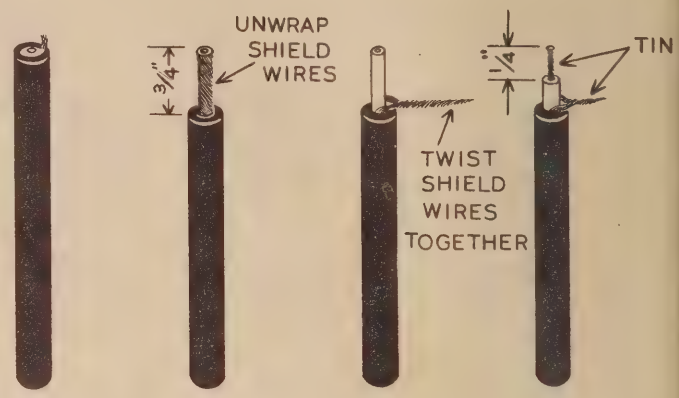



Figure 8

( ) 18. Cut a 3" length of shielded cable and prepare one end as shown in Figure 8. To remove the outer jacket, cut through it carefully so as not to cut the spiralled shield wires. It helps to flex the cable as this is done, so that the jacket is under tension at the point being cut. The cut part of the jacket may then be pulled off easily without having to slit it open.

( ) 19. Prepare the other end of the shielded cable in the same way, except that all the shield wires may be cut off. No connection will be made to the shield at this end. Connect the center conductor at this end to SC3 (S). Leave the other end free.

( ) 20. Strip one end of a 2" length of white wire for a distance of 5/8". Insert the bare wire through SD9 (NS) to SA9 (S). Now solder SD9. Leave the other end free.

( ) 21. Connect one end of a 2 1/2" length of green wire to SB10 (S). Leave the other end free.

( ) 22. Connect one end of a 10" length of blue wire to SD10 (S). Leave the other end free.

( ) 23. Connect one end of a 9" length of black wire to SD11 (S). Leave the other end free.

( ) 24. Connect one end of a 9" length of white wire to SD12 (S). Leave the other end free. Mount the switch on the back of the control panel, using <u>two</u> lockwashers instead of one. (See Figure 6.) Be sure position 1 is nearest the top edge of the panel.

This completes the SELECTOR switch sub-assembly.

( ) 25. Select the TREBLE tone control C. Figure 9 is a detailed drawing of the control and its associated wiring. Insert one lead of a .0022 μfd molded condenser through C1 (NS). Insert the other lead through C2 (NS). Pull the body of the condenser snugly against the right side of the control, crimp the leads to the terminals. Now solder C2.

( ) 26. Cut one lead of a 10 KΩ resistor to a length of 1", slip a 3/4" length of sleeving over the lead (Ins.) and connect to C1 (NS).

( ) 27. Connect one end of a 6" length of hookup wire to C1 (S).

( ) 28. Prepare a 4" length of shielded cable, as described in Figure 8. Again, as in Step 19, cut off all the shield wires at one end. Connect the center conductor at this end to C3 (NS).

( ) 29. Cut one lead of a 100 KΩ resistor (not one of the low-noise resistors) to a length of 3/4" (Ins.) and connect it to C3 (S).

( ) 30. Cut one lead of a 220 μμf ceramic condenser to a length of 3/4" and connect it to C4 (S).

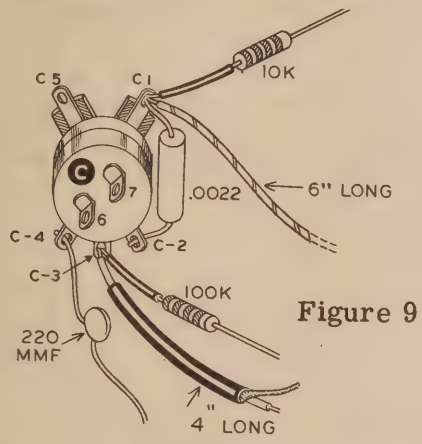


Figure 9

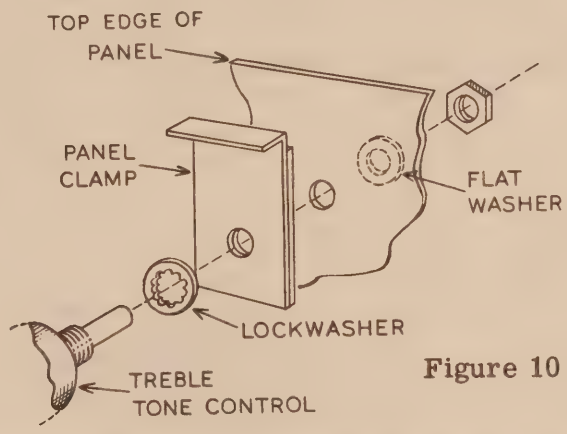


Figure 10

( ) 31. Mount the TREBLE control and the panel clamp on the back of the control panel. See Figure 10 for assembly details.

This completes the TREBLE tone control sub-assembly.

( ) 32. Select the BASS tone control B. Figure 11 is a detailed drawing of the control and its associated wiring. Following the procedure used in Step 25, connect a .022 μfd molded condenser from B1 (NS) to B2 (NS).

( ) 33. Now connect a .0022 μfd molded condenser from B1 (NS) to B4 (NS).

( ) 34. Using bare wire and sleeving, connect a lead from B1 (S) to B3 (NS).

( ) 35. Using the full length of the resistor lead, connect one end (Ins.) of a 47 KΩ resistor to B4 (S).

( ) 36. Mount the BASS tone control on the back of the control panel, using <u>two</u> lockwashers instead of one. See Figure 6. Be sure terminal 1 is nearest the top edge of the panel.

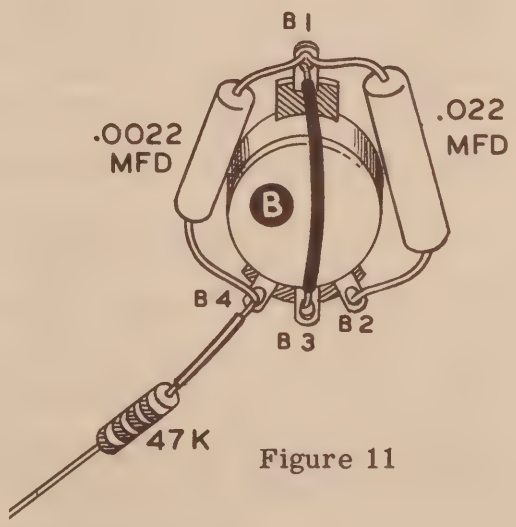


Figure 11

This completes the BASS tone control sub-assembly.

( ) 37. Prepare the ROLLOFF switch assembly R. This is the single-wafer switch bearing the part number 63-76 on the metal bracket. Figure 12 is a detailed drawing of the switch and its associated wiring. Identify contact 1 from this drawing. Connect a .0013 μfd ceramic condenser from R2 (Ins.) (S) to R8 (Ins.) (NS). Leave enough slack in the leads to prevent them from shorting to other parts of the switch.

( ) 38. In the same way, connect an 800 μμf ceramic condenser from R3 (Ins.) (S) to R7 (Ins.) (NS).

( ) 39. Next, connect a 420 μμf ceramic condenser from R4 (Ins.) (S) to R7 (Ins.) (NS).

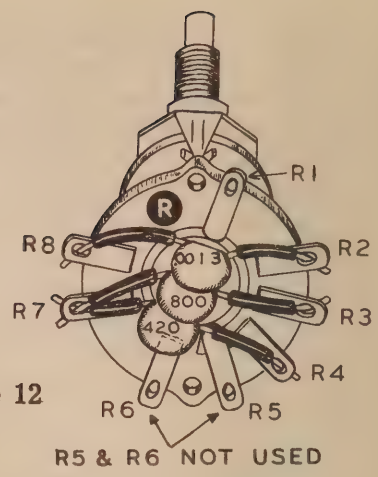


Figure 12

( ) 40. Mount the ROLLOFF control on the back of the control panel, using two lockwashers instead of one. See Figure 6. Be sure terminal 1 is nearest the top edge of the panel.

This completes the ROLLOFF switch sub-assembly.

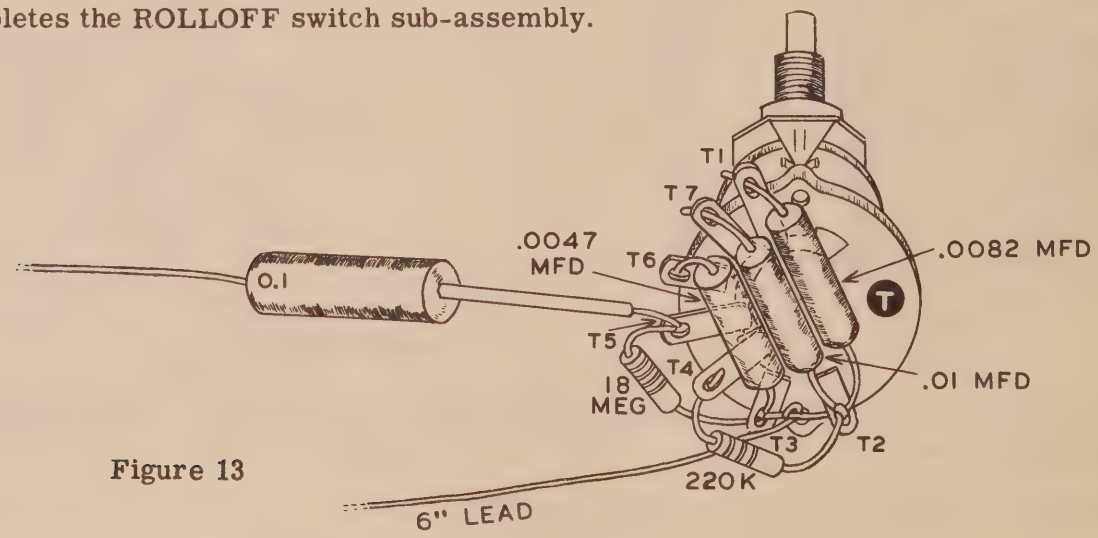


Figure 13

( ) 41. Prepare the TURNOVER switch assembly T. This is the remaining single-wafer switch bearing part number 63-75. Figure 13 is a detailed drawing of the switch and its wiring. Notice the location of terminal 1, which is to the left of center on this switch. Connect a .0082 μfd molded condenser from T1 (S) to T2 (NS).

( ) 42. Now connect a .01 μfd molded condenser from T7 (S) to T2 (NS).

( ) 43. Connect a .0047 μfd condenser from T6 (S) to T3 (NS).

( ) 44. Connect an 18 megohm resistor from T5 (NS) to T3 (NS).

( ) 45. Connect a 220 KΩ resistor from T4 (S) through T2 (NS) and back to T3 (S). Now connect one end of a 6" length of hookup wire to the resistor lead (S) between T2 and T3. Solder T2.

( ) 46. Cut one lead of a 0.1 μfd molded condenser to a length of 1 1/2" (Ins.) and connect this lead to T5 (NS). Leave the other lead of the condenser free.

( ) 47. Mount the TURNOVER switch on the back of the control panel, using only one lockwasher. Do not tighten the nut at this time. Be sure terminal 1 is near the top edge of the panel.

This completes the TURNOVER switch sub-assembly. The following steps complete the wiring between the various panel-mounted controls:

( ) 48. Cut a 5 1/4" length of the spring-like 1/4" diameter shield. Unwind about 1/2" of wire at one end and form a hook large enough to slip over the bracket of the SELECTOR switch S at the point between positions 2 and 3. Solder the hook to the bracket at this point. See Pictorial C.

( ) 49. Now cut a 5" length of the large plastic sleeving. Slip this over the shield and form a similar hook at the other end of the shield. Hook this over the bracket of the ROLLOFF switch R near contact 1. Solder the hook to the bracket.

( ) 50. Slip the blue, black and white leads (soldered to SD10, SD11 and SD12 of the SELECTOR switch) through the shield. Connect the blue lead to T5 (S) on the TURNOVER switch. Connect the white lead to R1 (NS) on the ROLLOFF switch. Connect the black lead through R8 (NS) on the ROLLOFF switch to R7 (S). Now solder R8.

( ) 51. Connect the free end of the 10 KΩ resistor (soldered to C1 on the TREBLE tone control) (Ins.) to B2 (S) on the BASS tone control.

( ) 52. Dress the 47 KΩ resistor (soldered to B4 on the BASS tone control) so that it lies over the body of the TREBLE tone control. Now connect the free end of the 100 KΩ resistor soldered to C3 on the TREBLE tone control) (Ins.) to B3 (S) on the BASS tone control.

Before proceeding, carefully recheck the wiring of the control panel against Pictorial C.

## LEFT-END BRACKET SUB-ASSEMBLY

( ) 53. Select the left end-bracket, the aluminum piece flanged on three sides, as sketched in Figure 14. Mount the condenser mounting wafer using the long 6-32 machine screws. Add a plastic cable clamp on the one mounting screw as shown. Do not tighten this screw at this time.

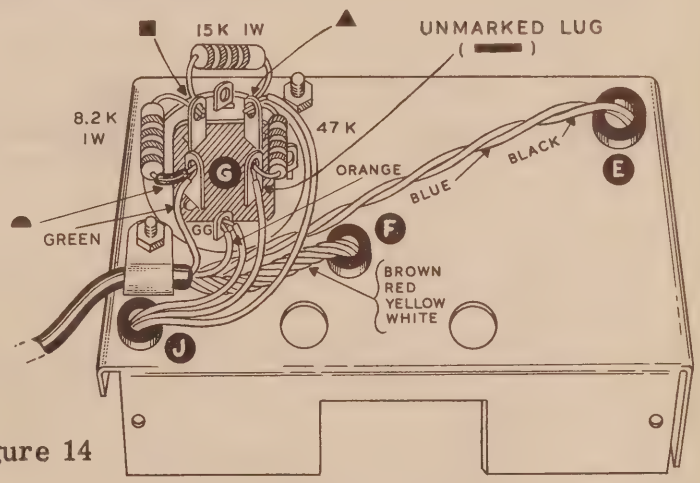


Figure 14

( ) 54. Now mount the filter condenser, the large aluminum can with the insulating insert at one end. Observe that adjacent to each terminal an identifying symbol has been punched in this insert. Orient the terminals so they correspond with Figure 14 and insert the flat mounting lugs through the slots in the wafer. Now twist each of the four mounting lugs about 1/8 turn with long nose pliers. Hold the condenser can firmly against the wafer while this is done. The twisted lugs will securely mount the filter condenser to the wafer.

( ) 55. Connect an 8.2 KΩ 1 watt resistor between G ▲ (Ins.) (NS) and G ■ (NS).

( ) 56. Connect a 15 KΩ 1 watt resistor between G ■ (S) and G ▲ (NS).

( ) 57. Connect a 47 KΩ resistor from G ▲ (NS) to G ▬ (NS).

( ) 58. Select the 9-foot length of 8-conductor cable. Remove the outer jacket to expose 14" of the conductors. This can be done easily by slitting the jacket with a sharp knife for a length of 14" and then peeling the jacket off by pulling with a pair of pliers. Loosen the screw holding the cable clamp. Insert the cable through the cable clamp so that the clamp bears on the jacket where the conductors fan out. Loosen the clamp mounting screw to do this. Retighten the clamp screw.

( ) 59. Cut the orange lead to an exposed length of 2", strip and connect to the twisted condenser mounting lug GG (NS) nearest the bottom of the bracket.

( ) 60. Similarly, cut the green lead to a 2" length and connect it to G ▲ (S).

( ) 61. Insert a 3/8" rubber grommet in the hole at E. Twist together the black and blue cable leads and insert them through the grommet.

( ) 62. Insert a 3/16" rubber grommet in the hole at F. Twist together the remaining cable leads; red, yellow, white and brown. Pass them through the grommet.

( ) 63. Connect one end of a 10" length of hookup wire to GG (S). Insert a 3/16" grommet at J and pass this lead through the grommet.

( ) 64. Connect one end of an 13" length of hookup wire to G ▲ (S). Pass this lead through the grommet at J.

( ) 65. Connect one end of a 7" length of hookup wire to G ▬ (S). Pass this lead through the grommet at J.

( ) 66. At the free end of the 8-conductor cable, remove the jacket for about 1 1/2". Strip each conductor to expose about 3/4" of bare wire. (See Figure 15.) Slip a 3/8" grommet on the cable. Slip the plug cap on the cable, with its grommet toward the bracket end of the cable.

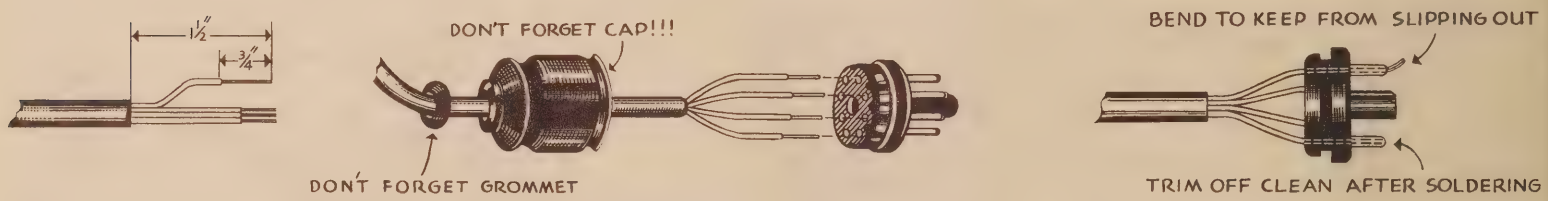



Figure 15

Note that the pin contacts of the octal plug are numbered from 1 to 8. Now twist the brown and yellow wires together and insert them through the phenolic body of the plug, into and through pin 1 so the bare wire extends about 1/4" beyond the pin. Connect the wires as follows:

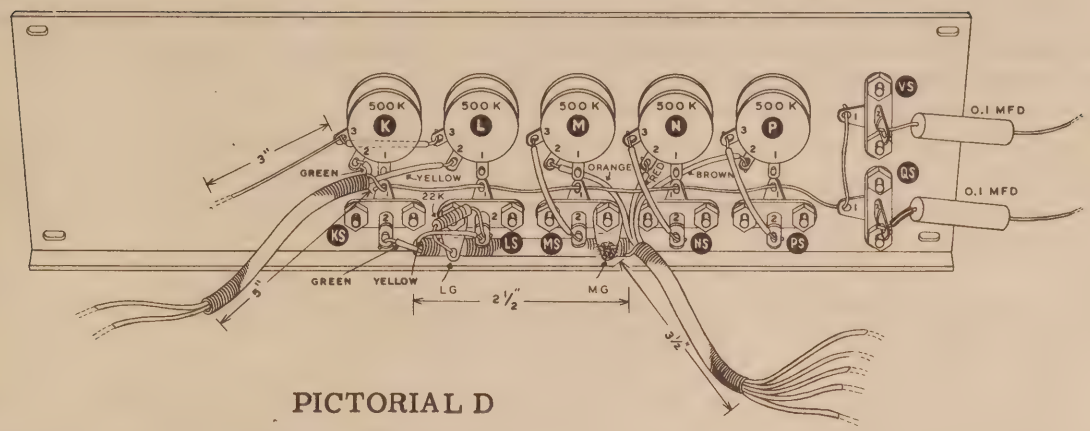
Brown and yellow to Pin 1
Red and white to Pin 2
Orange to Pin 3
No connection to Pin 4
Green to Pin 5
Blue to Pin 6
Black to Pin 7
No connection to Pin 8

( ) 67. Solder the wire in each pin by heating the pin with the soldering iron and letting the solder flow up into the pin. See that no excess solder sticks to the outside of the pin. If necessary, reheat the pin and wipe off the excess solder with a cloth. Cut off the bent over portion of wire and smooth the ends of the pin with an emery board, sandpaper or small file.

( ) 68. Press the cap over the plug so it snaps in place.

This completes the left-end bracket sub-assembly.

## REAR PANEL SUB-ASSEMBLY




PICTORIAL D

( ) 69. Identify the rear panel which is finished in gold and marked for the various input, output and level functions. Pictorial D is a drawing of the components and wiring associated with the panel. Mount the five LEVEL controls, using only one lockwasher as shown in Figure 6, positioning the terminals as shown so that the number 1 terminal is directly in line with the large hole between the control and the flange of the panel.

( ) 70. Cut 10" lengths of each of the following colors of hookup wire; brown, red, orange, yellow and green. Strip one end of each lead. Connect the brown lead to P2 (S). Leave the other end free.

( ) 71. Connect the red lead to N2 (S). Leave the other end free.

( ) 72. Connect the orange lead to M2 (S). Leave the other end free. Retain the yellow and green leads for later use.

( ) 73. Using 6-32 machine screws, lockwashers and nuts, mount the Mic. input socket KS directly below level control K, with the lug KS1 touching terminal K1 of the level control.

( ) 74. Mount input socket LS in the same fashion except use a solder lug, LG in place of the lockwasher on one of the screws.

( ) 75. Mount input socket MS, using a solder lug at MG as shown.

( ) 76. Mount input sockets NS, PS, QS and VS, using only lockwashers and nuts.

( ) 77. Dress the brown, red and orange leads flat against the panel and out over the flange between input sockets MS and NS.

( ) 78. Using bare wire, connect VS1 (S) to QS1 (S) to PS1 (S) to NS1 (S) to MS1 (S) to LS1 (S) to KS1 (NS). Pull the wire snug at each contact before soldering and be sure that a good solder connection is made between the number 1 lugs of the controls and the number 1 lugs of the input sockets. Do not solder KS1.

( ) 79. Using a 4" length of bare wire and sleeving, connect L3 (S) to K3 (S), leaving the extra wire connected at K3.

( ) 80. Using bare wire and sleeving, connect M3 (S) to MS2 (S).

( ) 81. Connect N3 (S) to NS2 (S).

( ) 82. Connect P3 (S) to PS2 (S).

( ) 83. From manufacturer's specifications, determine the proper load resistor for the magnetic phono pickup cartridge you will use. Connect a resistor of this value from LS2 (NS) to LG (NS). NOTE: A 22 KΩ resistor is furnished with your kit for this application. This is the recommended value for the General Electric reluctance pickup series and is a reasonable value for other types.

( ) 84. Cut a 6" length of shielding and at a point 3 1/2" from one end, insert a knife blade and separate the turns of the shield. Bend the shield at this point to form a right angle. Now slip the 10" lengths of yellow and green hookup wire (cut in Step 70) through the shield for its entire length.

( ) 85. Now slip the brown, red and orange leads (soldered to P2, N2 and M2) into the shield at the bend point and through the 3 1/2" length of the shield.

( ) 86. Lay the 2 1/2" length of the shield along the flange at the bottom under the two solder lugs LG and MG of the rear panel. It will be necessary to bend these lugs up slightly to insert the shield; bend them only enough to permit the shield to slip under. Support the free end of the shield so that it is perpendicular to the panel and flow solder over the lug MG so that a good connection is made to the short length of the shield.

( ) 87. Connect the panel end of the green lead to KS2 (S).

( ) 88. Connect the panel end of the yellow lead to LS2 (S).

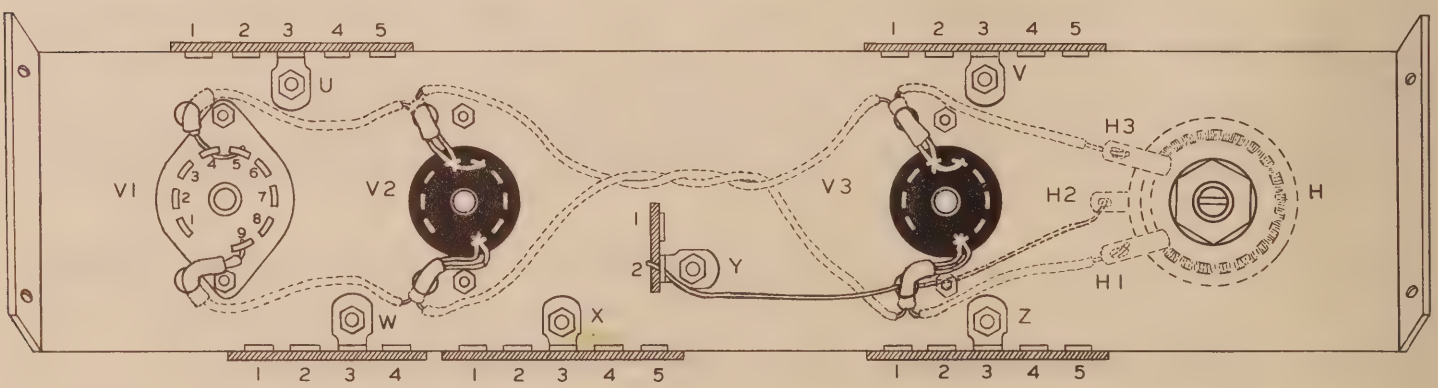
( ) 89. Cut a 5" length of shielding and at one end form a short hook by unwinding a turn of the shield. Solder this hook to KS1, being sure that solder flows over K1 also to make a good connection to both lugs.

( ) 90. Cut 8" lengths of green and yellow hookup wire, strip one end of each lead and slip the stripped end into the free end of the shield. At the panel end, connect the yellow wire to L2 (S) and the green wire to K2 (S).

( ) 91. Cut one lead of a 0.1 μfd condenser to a length of 3/4" and connect it to VS2 (S). Leave the other end free.

( ) 92. Cut one lead of a 0.1 μfd condenser to a length of 3/4" and connect it to QS2 (Ins.) (S). Leave the other end free.

This completes the rear panel sub-assembly and wiring.




PICTORIAL B

## CHASSIS WIRING

( ) 93. Place the assembled chassis on your bench with the tube socket contacts up, orienting it with Pictorial E which shows the completely wired chassis. Carefully bend down all the tube socket contacts. On socket V1, attempt to make a right angle at the lower hole through the contact. On sockets V2 and V3, attempt to make the bend at the lower end of the slot in the contact. This "fanning" operation will simplify the wiring and eliminate many possibilities for shorts between contacts as wiring is added.

Figure 16


PIN NUMBERING ON NOVAL TUBE SOC

NOTE: In steps 94, 95, 96 and 97, strip the wires back 3/4", twist the bare ends together and slip 1/2" lengths of sleeving over the wires and adjust them to protect against shorts or grounds at all points where they pass through the chassis holes. Refer to Figure 16 for numbering of socket contacts and to Pictorial B to see how sleeving is used.

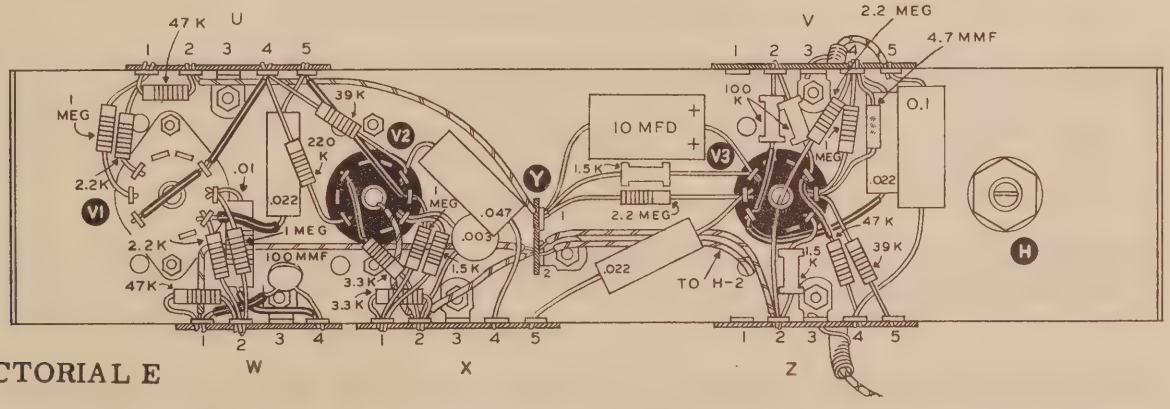
( ) 94. Cut a 3 1/2" length of hookup wire, strip both ends and connect one end to V1-9 (S). Pass the free end through the chassis using the hole near the gap, underneath the chassis and up through the hole near the gap at socket V2. Connect the end to V2-9 (NS).

( ) 95. Using a 3 3/4" length of wire, strip both ends to expose about 3/4" of bare wire. Pass the stripped end through V1-4 (NS) to V1-5 (S). Now solder V1-4. As in the step above, pass the wire below the chassis and up to socket V2, connecting the other end through V2-4 (NS) to V2-5 (S).

( ) 96. Cut and strip both ends of two 6" lengths of hookup wire, one black and one brown. As above, connect one end of the black lead to V2-9 (S). Connect one end of the brown lead to V2-4 (S). Pass the free ends through the chassis holes and twist the two leads together for about 2". Fan the leads out and pass the black lead up and connect it to V3-9 (NS). Connect the brown lead through V3-4 (NS) to V3-5 (S).

( ) 97. Similarly, connect a black lead from V3-9 (S) to H1 (NS) on the HUM control. Connect a brown lead from V3-4 (S) to H3 (NS).

See Pictorial E for the following wiring:




PICTORIAL E

( ) 98. Connect a lead from H2 (S) through the hole near V3-1 to Y2 (NS) on the 2-lug terminal strip Y.

( ) 99. Connect a lead from U2 (NS) on the 5-lug terminal strip U to Y1 (NS).

( ) 100. Connect a lead from W1 (NS) on the 4-lug terminal strip W to Y2 (NS).

( ) 101. Connect a lead from Z2 (NS) on the 5-lug terminal strip Z to Y2 (NS).

( ) 102. Connect a lead from X2 (NS) on the 5-lug terminal strip X to Y2 (NS).

( ) 103. Connect a lead from the tubular shield in the center of socket V2 (NS) to X2 (NS).

( ) 104. Using bare wire and sleeving, connect a lead (Ins.) from U4 (NS) through V1-6 (NS) (Ins.) to V1-1 (S). Now solder V1-6.

In making the following connections, it is imperative that the bodies of the condensers be kept as close to the chassis as possible. Use care in cutting leads and make all connections as short and direct as possible. Follow Pictorial E carefully for the exact location of the condensers and resistors. Figure 17 suggests a method of connecting leads to terminal strips which helps keep components against the chassis.

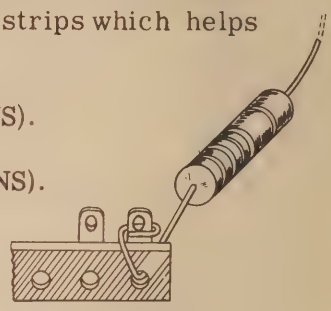


Figure 17

( ) 105. Connect a .01 μfd molded condenser from V1-7 (NS) to W4 (Ins.) (NS).

( ) 106. Connect a .022 μfd molded condenser from V1-8 (Ins.) (NS) to U5 (NS).

( ) 107. Connect a .047 μfd molded condenser from V2-6 (NS) to X4 (NS).

( ) 108. Connect a .022 μfd molded condenser from V3-2 (NS) to X5 (NS).

( ) 109. Connect a .022 μfd molded condenser from V3-1 (Ins.) (NS) to V4 (NS).

( ) 110. Connect a .1 μfd molded condenser from V5 (NS) to Z4 (NS).

( ) 111. Connect the positive lead (marked +) of the 10 μfd electrolytic condenser to V3-3 (NS). Connect the negative lead of this condenser to Y1 (NS).

( ) 112. Connect a .003 μfd ceramic condenser from V2-8 (NS) to X2 (Ins.) (NS). Lay the body of this condenser flat against the chassis as shown.

( ) 113. Connect a 47 KΩ resistor from U1 (NS) to U2 (NS).

( ) 114. Connect a 47 KΩ resistor from W1 (NS) to W2 (NS).

( ) 115. Connect a 100 μμf ceramic condenser from W1 (Ins.) (S) to W4 (NS).

( ) 116. Connect a 3.3 KΩ resistor from X1 (NS) to X2 (NS).

( ) 117. Connect a 1 megohm resistor from U1 (NS) to V1-2 (NS).

( ) 118. Connect a 2.2 KΩ resistor from U1 (S) to V1-3 (NS).

( ) 119. Connect a 1 megohm resistor from V1-7 (S) to W2 (NS).

( ) 120. Connect a 2.2 KΩ resistor from V1-8 (S) to W2 (S). It is important that this resistor be placed exactly as shown in Pictorial E.

( ) 121. Connect a 220 KΩ resistor from U4 (NS) to V2-1 (NS).

( ) 122. Using bare wire and sleeving, connect a lead from U5 (NS) to V2-7 (NS).

( ) 123. Connect a 39 KΩ resistor from U4 (NS) to V2-6 (S).

( ) 124. Connect a 3.3 KΩ resistor from V2-3 (Ins.) (S) to X2 (S).

( ) 125. Connect a 1.5 KΩ resistor (not one of the low-noise resistors) from V2-8 (S) to X1 (NS).

( ) 126. Connect a 1 megohm resistor from V2-7 (S) to X1 (S).

( ) 127. Connect a brown, low-noise 1.5 KΩ resistor from V3-3 (S) to Y1 (NS).

( ) 128. Connect a 2.2 megohm resistor from V3-2 (S) to Y1 (NS).

( ) 129. Connect a brown low-noise 100 KΩ resistor from V2 (NS) to V3-1 (Ins.) (S).

( ) 130. Connect a brown low-noise 100 KΩ resistor from V2 (NS) to V3-6 (NS).

( ) 131. Connect a brown low-noise 1.5 KΩ resistor from Z2 (NS) to V3-8 (S).

( ) 132. Connect a 1 megohm resistor from V4 (NS) to V3-7 (NS).

( ) 133. Now connect a 4.7 μμf ceramic condenser from V4 (NS) to V3-7 (NS).

( ) 134. Connect a 39 KΩ resistor from V3-7 (S) to Z5 (NS).

( ) 135. Connect a 47 KΩ resistor from V3-6 (Ins.) (S) to Z4 (S).

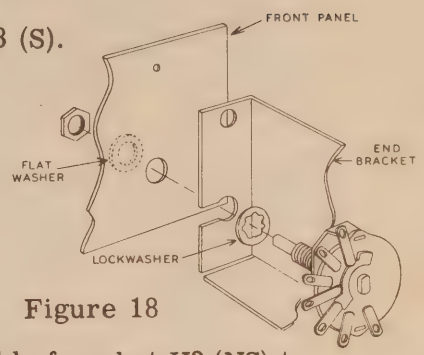


Figure 18

( ) 136. Pass one lead of a 2.2 megohm resistor through the center shield of socket V3 (NS) to Z2 (NS). Now solder the lead at the center shield. Connect the other lead of the resistor to V4 (S).

( ) 137. Cut a 3" length of the 1/4" spiral shielding and unwind one end to provide about 3/4" of wire. Place the shield underneath and across the chassis, using the notches in the chassis flanges near V3 and Z3. Using the unwound portion, connect one end of the shield to V3 (S). Rewind the spring slightly if necessary so that the shield is held firmly in the flange notch. At the other end of the shield, form a hook from bare wire and secure the shield in the notch by soldering the hook to the shield and to terminal Z3.

( ) 138. Cut and strip one end of a 7" length of hookup wire. Connect the stripped end to V5 (NS). Slip the free end of the lead through the shield.

This completes the chassis wiring. Before proceeding with the next operation, carefully recheck the wiring against Pictorial E. Recheck the color codes of resistors and condensers. Be sure the proper part has been used in each location.

## FINAL ASSEMBLY AND WIRING

Refer to Pictorials F and G.

( ) 139. Secure the bracket and condenser sub-assembly to the panel. Loosen the nut holding the TURNOVER control to the panel. The short wide flange of the bracket is slotted to accept the bushing of the TURNOVER control. The lockwasher goes between the switch bushing and the inside of the bracket. See Figure 18. DO NOT tighten the TURNOVER control nut yet.

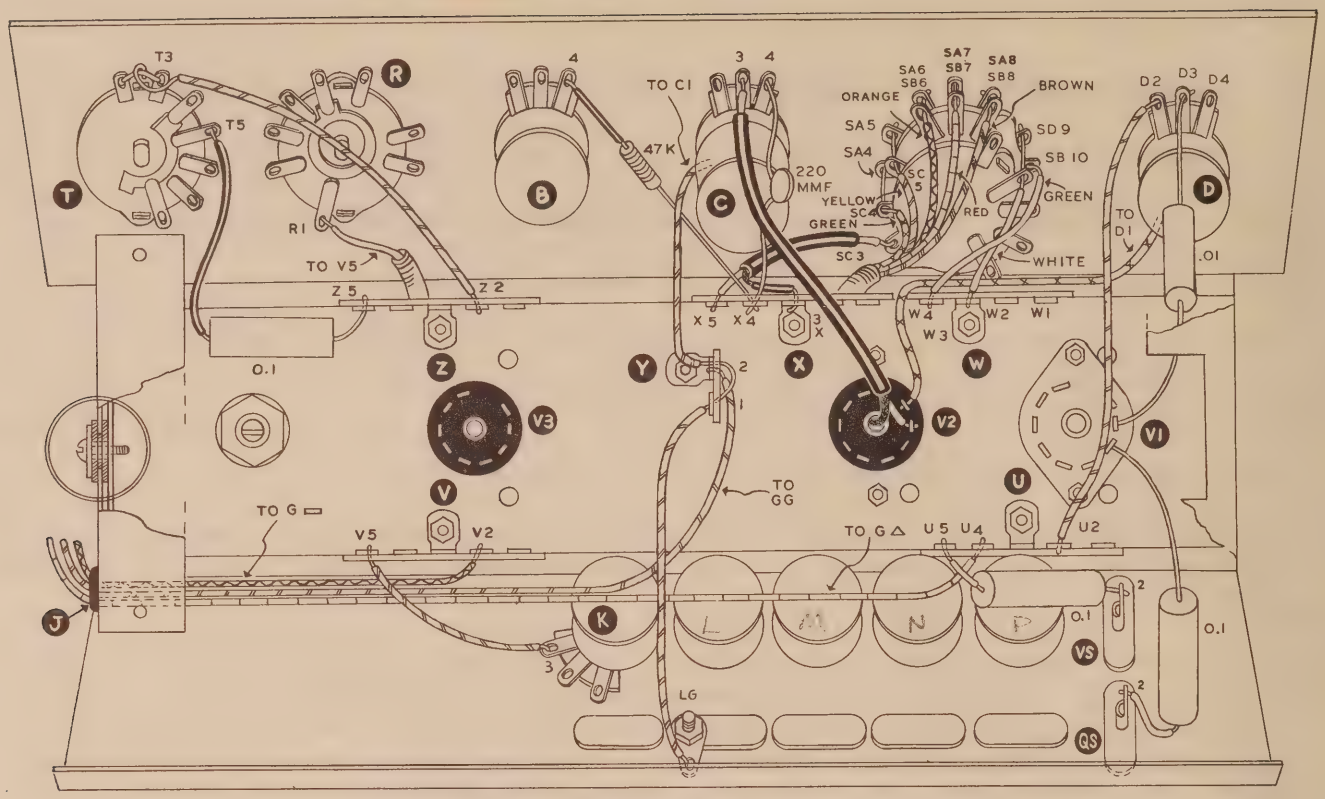
( ) 140. Cut a 6 1/2" length of spiral shielding and unwind about 1/2" of the wire at one end. Slip this wire through C5 (NS) on the TREBLE tone control. Solder the wire to the case of the control, then solder C5.

( ) 141. Slip a 6" length of plastic tubing over the shield. Remove the blue and black leads from grommet E, insert the free end of the shield in the grommet and slip the blue and black leads through the shield. Connect either lead to C6 (S) and the other lead to C7 (S).

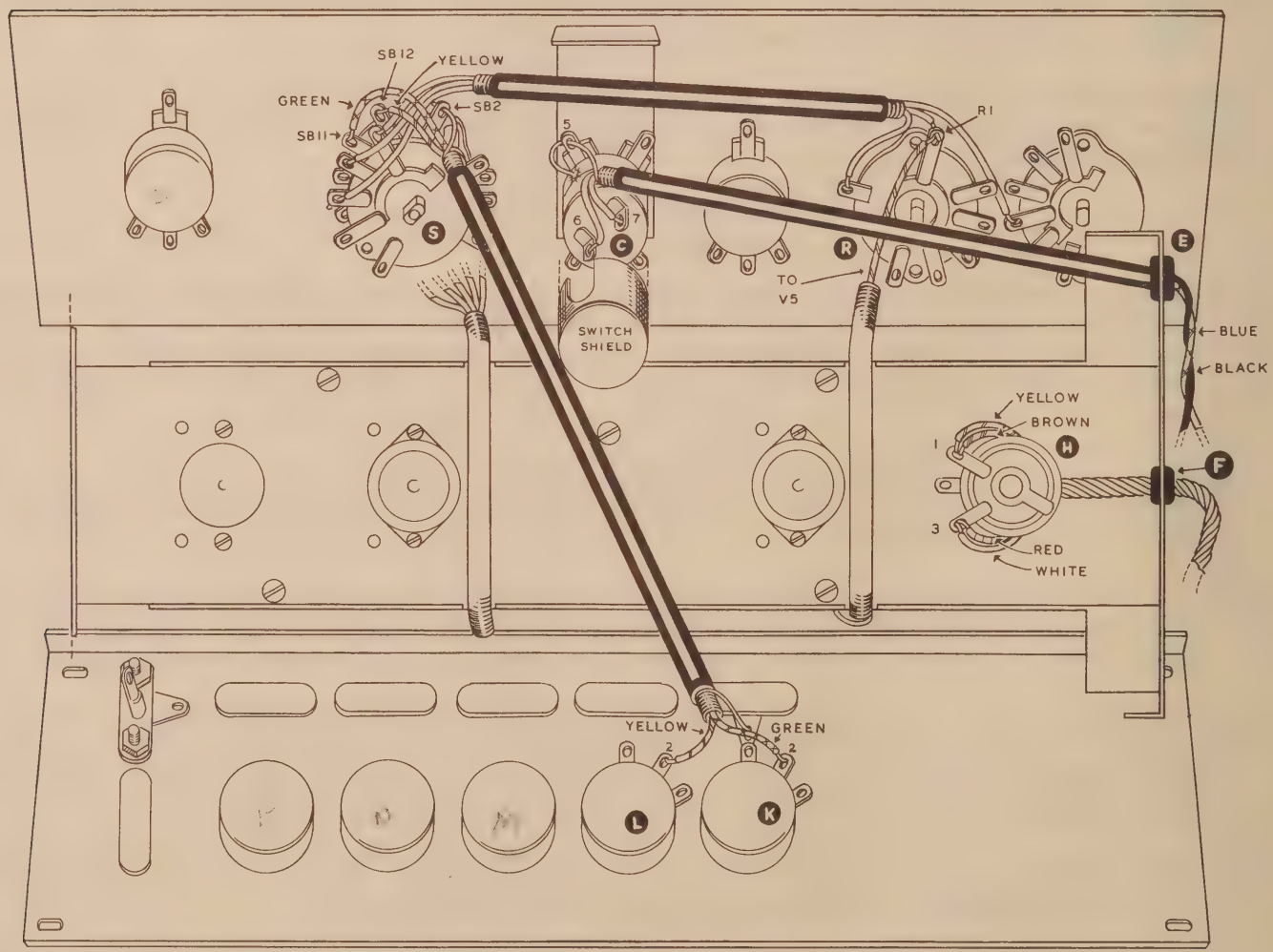
( ) 142. Dress the unshielded parts of the blue and black leads tightly against the case of the control. Then snap the line switch shield (the cup-like metal part with a slot in the wall) over the back of the TREBLE tone control. Be sure the insulating insert is inside the shield and that the slot clears the blue and black leads without pinching them.

( ) 143. Dress all the free lead ends and component pigtails of the panel control so that they extend straight down toward the bottom edge of the control panel.

( ) 144. Insert two of the large 7/16" soft rubber grommets in the remaining holes of the left-




PICTORIAL F




PICTORIAL G

end bracket. Then push the two 3/16" spacers into the center holes of the grommets. Place a 9/16" flat metal washer on a 6-32 self-tapping screw and insert the screw through the spacer. (See detail in Pictorial F.) Position the assembled chassis with HUM control nearest the left-end bracket and the end flange turned away from the filter condenser. Now carefully secure the chassis to the bracket, using the 1/2" self-tapping screw. Before tightening the screw, start the second self-tapping screw in the other mounting hole of the flange.

( ) 145. Now mount the right-end bracket to the front panel, following the procedure in Step 139 but using the VOLUME control bushing to secure the bracket. DO NOT tighten the VOLUME control nut yet.

( ) 146. Insert the shock-mount grommets and spacers in the right-end bracket. Install two 1/2" self-tapping screws to secure the right end of the chassis to the bracket.

NOTE: The slot in the panel flanges of the end brackets will permit them to be moved left or right to accomodate variations in the length of the chassis. We suggest that you tighten the shock-mount screws firmly, then adjust the position of the end brackets so that the small hole at the left top corner of the panel is approximately centered at the top of the larger hole in the left-end bracket flange. Then tighten the control nuts temporarily.

( ) 147. Cut the group of four wires (extending through grommet F) to length to reach H1 and H3 on the HUM control. Fan out the leads, strip all four ends, twist together the bare ends of the brown and yellow leads and similarly connect the red and white leads. Twist the two pairs together for about three full turns. Connect the brown-yellow pair to H1 (S). Connect the red-white pair to H3 (S). Pull any excess slack out of this cable by dressing against the outside of the left-end bracket.

Underneath the chassis, connect the leads coming through the grommet J:

( ) 148. The lead connected to GG on the filter condenser goes to Y2 (NS) on the 2-lug terminal strip.

( ) 149. The lead from G ▬ goes to V2 (S).

( ) 150. The lead from G ▲ goes to U4 (S).

Connect the leads from the TURNOVER control:

( ) 151. The lead connected to T3 goes to Z2 (S) on the 5-lug terminal strip Z.

( ) 152. The free end of the 0.1 μfd condenser connected to T5 goes to Z5 (S). Place the body of the condenser as shown in Pictorial F.

Connect the leads from the SELECTOR switch:

( ) 153. The 2" white lead connected to SD9 goes to W3 (S) on the 4-lug terminal strip W.

( ) 154. The 2 1/2" green wire connected to SB10 should be twisted twice around the white wire on SD9, then connected to W4 (S).

( ) 155. The center conductor of the shielded cable connected to SC3 goes to X5 (S) on the 5-lug terminal strip X. The shield pigtail on this lead goes to X3 (S) (Ins.). Make both these connections, X5 and X3, at the rivet where the terminal lug is fastened to the phenolic strip.

Connect the lead from the BASS tone control:

( ) 156. The free end of the 47 KΩ resistor connected to B4 goes to X4 (NS) on the 5-lug terminal strip X.

Connect the leads from the TREBLE tone control:

( ) 157. The lead connected to C1 goes to Y2 (NS) on the 2-lug terminal strip Y.

( ) 158. The free end of the 220 $\mu\mu$f ceramic condenser connected to C4 goes to X4 (S) on the 5-lug terminal strip X.

( ) 159. The center conductor of the shielded lead connected to C3 goes to V2-2 (S). The shield pigtail on this lead goes to the center shield of socket V2 (S).

Connect the leads from the VOLUME control:

( ) 160. Connect the 6" lead from D1 to V2-1 (S) on tube socket V2. (Dress this lead along the front of the chassis flange to the gap between terminal strips W and X, then straight back to socket contact V2-1 as shown in Pictorial F.)

( ) 161. Connect the 6" lead from D2 straight back across the chassis to U2 (S) on the 5-lug terminal strip U.

( ) 162. Connect the free end of the .01 $\mu$fd condenser (soldered to D3) to V1-2 (S).

This completes the control panel to chassis wiring. The rear panel is now added and wired to the chassis.

( ) 163. Before mounting the rear panel, bend the lead of the 0.1 $\mu$fd condenser connected to QS2 as shown in Pictorial F. Then slip the rear panel in place, being sure that this condenser is placed between terminal strip U and the flange of the chassis. Attach the rear panel to the end brackets, using two 6-32 self-tapping screws through the lower slots of the panel. Do not install the two top screws at this time.

( ) 164. Place the shield containing the five leads in the notches in the chassis flanges, so that the shield crosses the chassis between tube sockets V2 and V3. Do not solder the shield in place yet. Push the five leads down toward the bottom contacts of the SELECTOR switch. Carefully cut the leads to length to reach the following switch contacts:

| | |
|---|---|
| Brown to SA8 | Red to SA7 |
| Orange to SA6 | Yellow through SC5 to SA5 |
| Green through SC4 to SA4 | |

Now pull the leads and the shield up above the chassis and strip the five leads. Remember that the yellow and green leads should be stripped at least 1/2".

( ) 165. Replace the shield in the front notch and secure it by using a hook soldered to X3 at the top. No hook is needed at the rear flange.

( ) 166. Connect the green wire through SC4 (NS) to SA4 (S). Now solder SC4.

( ) 167. Connect the yellow wire through SC5 (NS) to SA5 (S). Now solder SC5.

( ) 168. Connect the orange wire through SB6 and SA6. Solder both terminals.

( ) 169. Connect the red wire through SB7 and SA7 and solder both.

( ) 170. Connect the brown wire through SB8 and SA8 and solder both.

( ) 171. Above the chassis, slip a length of 1/4" plastic tubing over the shield containing the two leads. Be sure this tubing prevents the shield from touching the chassis flange or any contacts on the SELECTOR switch.

( ) 172. Unwind a short length of this shield and hook it to SB2 (NS). Cut the green wire to length to reach SB11 and the yellow wire to reach SB12. Unhook the shield, strip the two wires and rehook the shield and solder to SB2. Now solder the green wire to SB11 and the yellow wire to SB12.

( ) 173. The free end of the lead attached to V5 and coming through the other shield should be connected to R1 (S) on the ROLLOFF switch. Bend the shield so it clears R7.

( ) 174. Underneath the chassis, connect the short bare wire from K3 (on the MIC level control) to V5 (Ins.) (S).

( ) 175. Connect the free end of the 0.1 μfd condenser (soldered to VS2) to U5 (Ins.) (S). Place the body of the condenser directly behind the LEVEL control P.

( ) 176. Connect the free end of the 0.1 μfd condenser (soldered to QS2) to V1-3 (Ins.) (S) on tube socket V1.

( ) 177. Connect a lead from LG (the ground lug near the PHONO input socket) (S) through Y1 (NS) to Y2 (S). Now solder Y1. Also solder the lug LG to the spiral shielding.

This completes the actual wiring of the preamplifier. Before the cabinet shell and bottom are added, the unit should be tested.

## IMPORTANT NOTICE

If this preamplifier is to be used with a Heathkit model WA-1, W-2M or W-3M Williamson-type Amplifier, the following changes must be made in the main amplifier before the preamplifier is plugged in. (See Pictorial H.) No changes are required in the models W-4M, W-4AM or W-5M when used with the WA-P2.

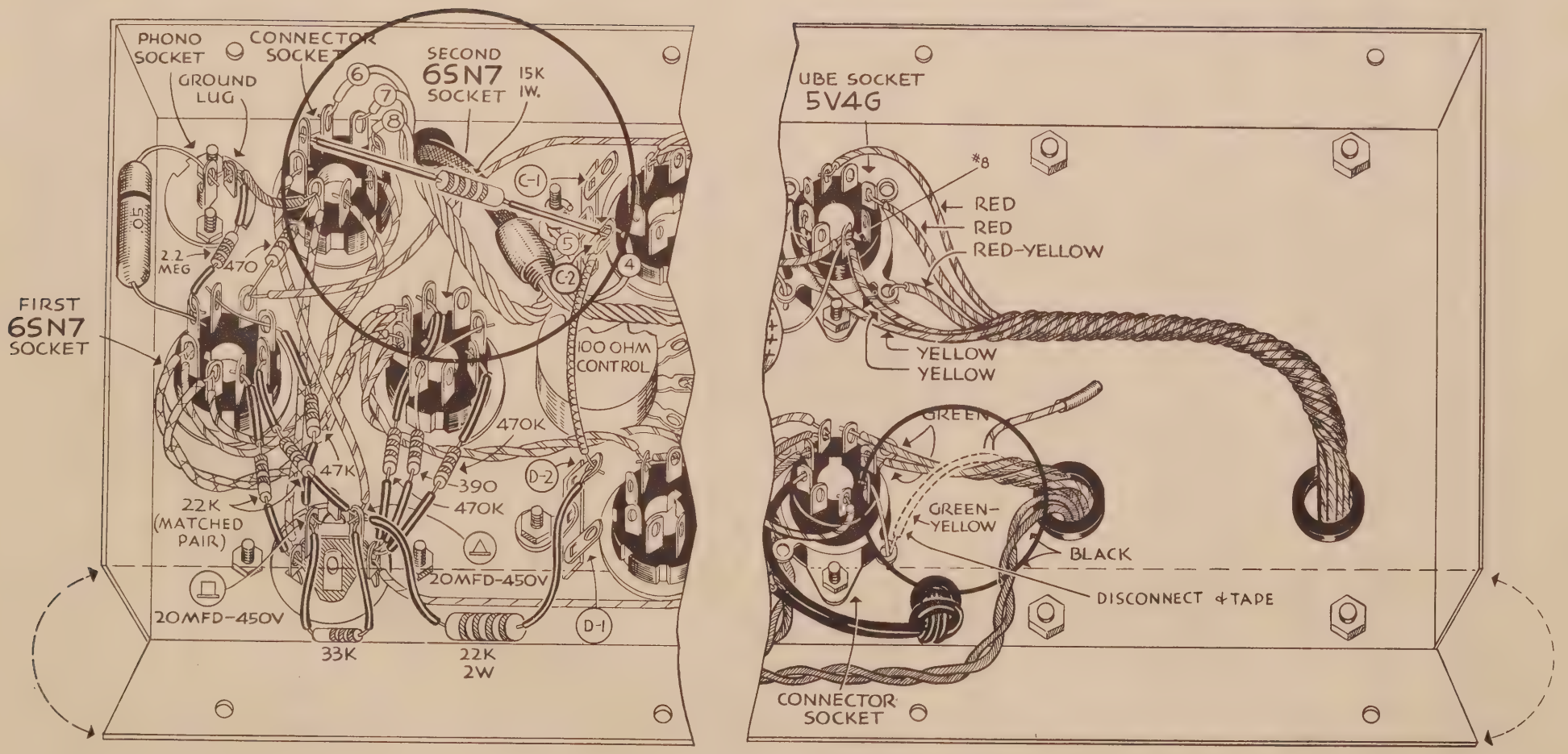
( ) 178. Remove the bottom cover of the power supply chassis. Carefully unsolder the green-yellow transformer lead connected to the ground lug of the connector socket. DO NOT disconnect the lead from pin 3 of the socket to this ground lug. This removes any connection between the filament circuit and the chassis of the main amplifier. Tape the free lead and replace the bottom cover.

( ) 179. Remove the bottom cover of the main amplifier chassis. Connect the 15 KΩ 1 watt resistor from the blank pin 5 on the connector socket (use sleeving) (S) to terminal C2 (S) on the 2-lug terminal strip between the connector socket and the 5881 tube socket. (C2 is the terminal nearer the center of the chassis.) The body of the resistor can be placed directly against the chassis below the 0.25 μfd condenser. Replace the bottom cover.

If the preamplifier is to be used with any other power source, make an adapter to supply the following voltages to the octal connector on the 8-conductor cable:

Pin 1 - One side of filament circuit, 6.3 V at 1.0 amp. AC
Pin 2 - Other side of filament circuit*
Pin 3 - Negative plate supply
Pin 4 - No connection
Pin 5 - Positive plate supply, 300 volts at 10 ma DC
Pin 6 and Pin 7 - AC switch terminals
Pin 8 - No connection

*Filament circuit must be isolated from chassis or plate supply.




MAIN AMPLIFIER CHASIS

PICTORIAL H

POWER SUPPLY CHASIS

Assuming that necessary provisions for power have been made, the following preliminary steps should be taken before the preamplifier is tested:

(✓) 180. Insert tubes in the sockets as follows:

Socket V1 - type 12AU7
Socket V2 - type 12AX7
Socket V3 - type 12AX7

(✓) 181. Place tube shields over the tubes in sockets V2 and V3.

(✓) 182. Slip knobs on the control shafts. Small knobs are used on the TURNOVER, ROLLOFF, BASS and TREBLE controls. Large knobs are used on the SELECTOR and VOLUME controls. The knobs push on the flatted shafts, after proper alignment between the flat and the spring insert in the knob. If necessary, loosen the control nuts to secure proper relation between the knob indicator line and the panel markings. Then retighten the nuts.

(✓) 183. Mount the HEATHKIT nameplate on the front panel. Cut the plastic pins to a length of 1/4". Insert the pins through the small holes in the upper left corner of the panel. Touch the ends of the pins with a soldering iron so that the plastic material flows enough to secure the nameplate to the panel.

(✓) 184. Set the controls on the preamplifier as follows:

TURNOVER to "LP"
ROLLOFF to "0"
BASS indicator vertical
TREBLE to "AC OFF"
SELECTOR to "1"
VOLUME full counterclockwise.
All LEVEL controls (on rear panel) full clockwise.

( ) 185. Plug the octal connector into the applicable socket on the main amplifier (or other power source). Temporarily secure the bottom plate to the end-brackets, using 6-32 self-tapping screws. The large center hole should provide access to the HUM control.

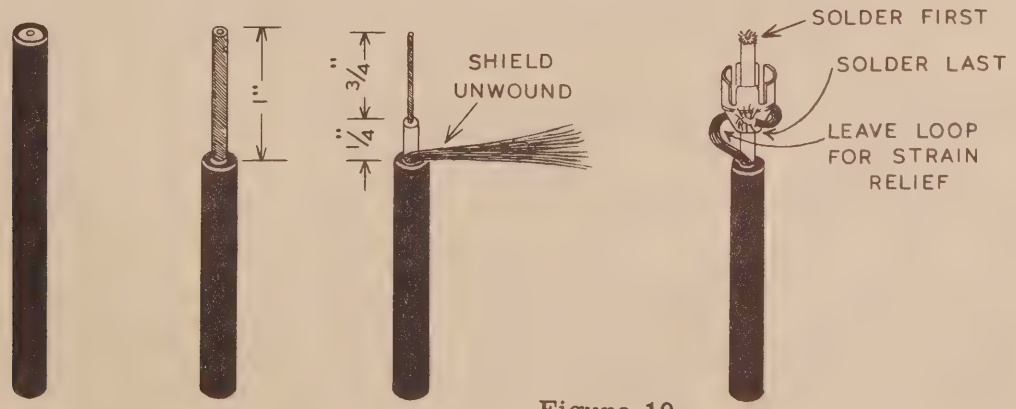



Figure 19

(✓) 186. Prepare a length of shielded cable as shown in Figure 19, using a phono plug at each end. Connect this cable from the TO PWR. AMP. INPUT socket on the preamplifier rear panel to the input socket on the main amplifier.

( ) 187. Be sure a speaker is connected to the output of the main amplifier.

( ) 188. Plug the main amplifier (or other power source) line cord into an AC outlet.

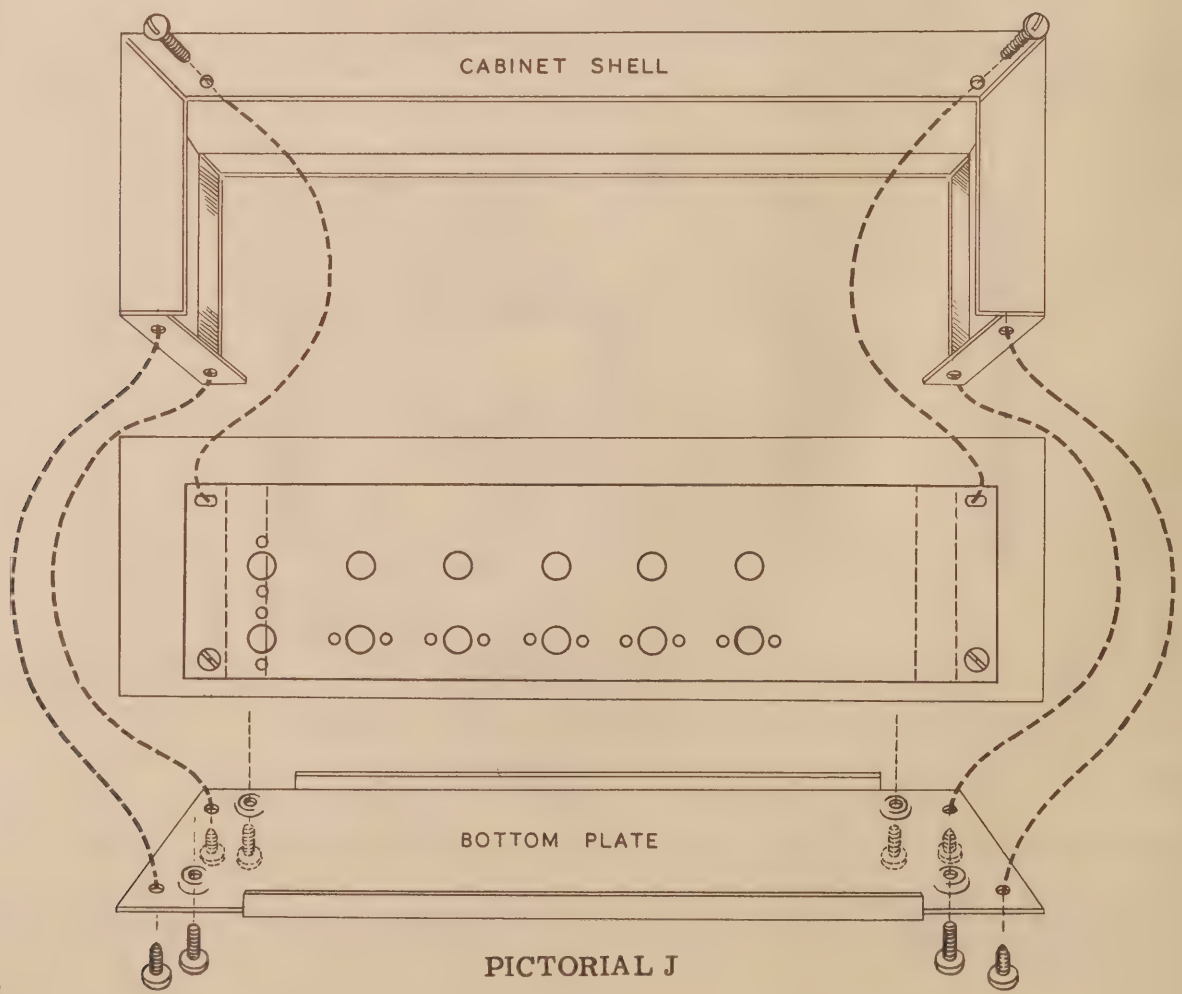
( ) 189. Turn the TREBLE tone control so the indicator line is vertical. The tube filaments should light. Allow one minute for tubes to heat, then rotate the VOLUME control clockwise

until background noise is heard in the speaker. This noise will quite probably be mostly low frequency hum. Rotate the BASS tone control. The hum should increase with clockwise rotation of the BASS control and vice versa. Now set the SELECTOR switch to the 2 and TUNER settings. These inputs should give exactly the same results as the 1 setting.

( ) 190. Turn the VOLUME control full counterclockwise. Turn the SELECTOR switch to the PHONO position and again rotate the VOLUME control until background noise is heard. The noise level will be considerably higher than before. Rotate the BASS control full clockwise and carefully adjust the HUM control below the chassis for minimum hum. Advance the VOLUME control as this is done. The setting for minimum hum is quite critical. With full volume on, rotate the TREBLE tone control and observe that the high-frequency noise or rushing sound increases as the control is turned clockwise. With full volume on and the TREBLE control clockwise, operate the ROLLOFF control. The high-frequency noise should reduce to successively lower values as the control progresses clockwise. With full volume and the BASS control full clockwise, operate the TURNOVER control. There will be very slight changes in the hum level in the LP, NARTB and AES positions, but a definite increase in hum when the control is set to EARLY 78. If the controls function as described, rotate the SELECTOR control to the MIC setting and again check for background noise. In this position, the overall noise level will be slightly higher than in the phono position, but the hum component will be reduced appreciably, since no low-frequency boost is introduced as in the PHONO position.

If the preamplifier behaves as described above, you may assume that it has been correctly assembled and wired. If operation is abnormal, refer to a later portion of this manual, entitled, "In Case of Difficulty."

BE SURE THAT THE OCTAL PLUG IS NOT CONNECTED TO THE POWER AMPLIFIER WHEN PERFORMING THE FOLLOWING OPERATIONS.




PICTORIAL J

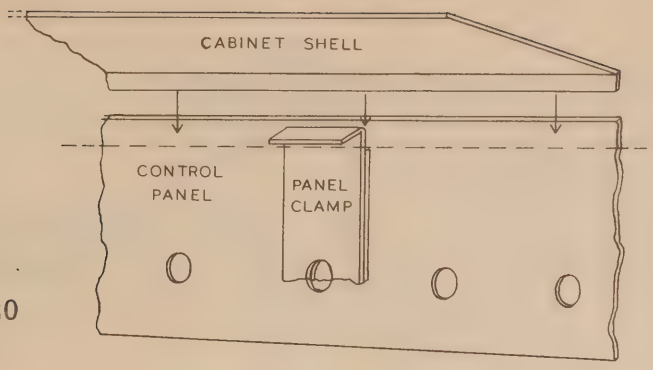


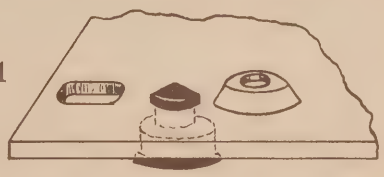

Figure 20

( ) 191. Remove the bottom plate. Drop the cabinet shell over the preamplifier as shown in Figure 20. The narrow flange on the shell goes next to and behind the front panel. Work the grommet on the cable into its notch in the left rear flange. The panel clamp, mounted on the TREBLE tone control bushing, should bear on the inside of the front flange of the shell. This prevents any bowing of the front panel at the center. See Figure 20.

( ) 192. Insert two 6-32 x 1/2" self-tapping screws through the two small holes in the top rear flange of the shell. These screws will pass through slots in the rear panel and thread into the end brackets.

( ) 193. Insert the four rubber feet through the 1/4" holes at the four corners of the bottom plate. See Figure 21.

Figure 21



( ) 194. Turn the preamplifier upside down. Orient the bottom plate so that the large hole falls over the HUM control shaft and attach the bottom plate to the shell (not to the end brackets) using the outside holes at each corner. Sheet metal screws are used for this application.

( ) 195. Remove the knobs from the VOLUME and TURNOVER control shafts. Loosen the nuts mounting these controls slightly so that the panel may be shifted on the end brackets. Be careful not to loosen the nuts too far.

( ) 196. Using 1/2" self-tapping screws, secure the bottom plate to the end brackets through the dimpled holes in the bottom plate.

( ) 197. Adjust the position of the front panel so that an even alignment to the cabinet shell is obtained. Now retighten the VOLUME and TURNOVER control nuts and replace the knobs.

This completes the assembly and adjustment of your Heathkit WA-P2 Preamplifier kit.

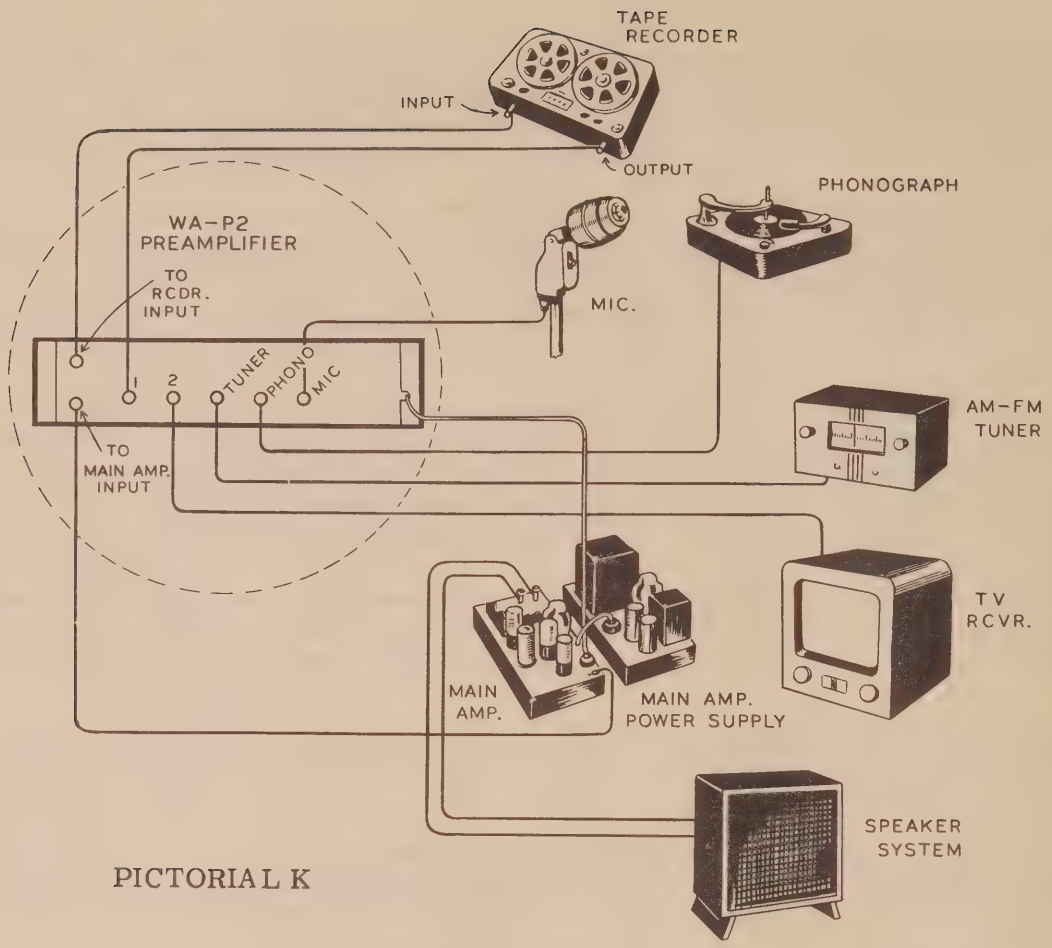
## INPUT CONNECTIONS

Most signal sources terminate in a standard RETMA phono plug which fits the input sockets of your WA-P2 Preamplifier. Two plugs of this type are furnished with your kit and may be attached to other equipment where needed. All input leads should be shielded with stranded center conductors for greater flexibility. Connect inputs in accordance with the following table:

| 1, 2 or TUNER | PHONO | MIC |
|---|---|---|
| AM, FM or TV receivers | Reluctance phono pickups | High-impedance microphones |
| Tape recorder output | Magnetic phono pickups | Contact microphones for musical instruments |
| Crystal or ceramic phono pickups* | Crystal or ceramic phono pickups* | Compensated phono pickups with no preamplifier |
| Capacity (FM) phono pickups with required oscillator | Ribbon phono pickups, with matching transformer | |
| Compensated phono pickup preamplifiers (all types) | | |

Pictorial K shows the WA-P2 as it would be used with a comprehensive high-fidelity system.

*See Boegli; "New Developments in Phono Equalizers," Radio and Television News, April, 1953




PICTORIAL K

## HOW TO USE THE TURNOVER AND ROLLOFF CONTROLS

These controls compensate the response of the preamplifier to correct for the recording characteristic used by the various manufacturers. A committee of the Record Industry Association of America has recently approved a standard curve, to be known as the "RIAA Standard Recording and Reproducing Characteristic." This committee is composed of representatives of Capitol, Columbia, Decca, Mercury and RCA Victor. It may be assumed that the use of the curve will become widespread in the future. THIS CHARACTERISTIC MAY BE MATCHED BY SETTING THE TURNOVER AND ROLLOFF CONTROLS TO THE "RIAA" POSITIONS.

For recordings released prior to 1954, use the following table as a guide for setting these controls:

| LP Records labelled | TURNOVER | ROLLOFF | LP Records labelled | TURNOVER | ROLLOFF |
|---|---|---|---|---|---|
| Atlantic | RIAA | 16 | London | LP | 8 |
| Bartok | AES | 16 | Lyricord | AES | 16 |
| Blue Note Jazz | AES | RIAA-12 | Mercury | AES | RIAA-12 |
| Caedmon | AES | RIAA-12 | M-G-M | RIAA | RIAA-12 |
| Canyon | AES | RIAA-12 | Oceanic | LP | 16 |
| Capitol | AES | RIAA-12 | Philharmonia | AES | RIAA-12 |
| Capitol-Cetra | AES | RIAA-12 | Polymusic | RIAA | 16 |
| Cetra-Soria | AES | RIAA-12 | RCA-Victor | RIAA | RIAA-12 |
| Columbia | LP | 16 | Remington | RIAA | 16 |
| Cook Laboratories | RIAA | RIAA-12 | Tempo | RIAA | RIAA-12 |
| Decca | AES | RIAA-12 | Urania | LP | 16 |
| Electra | AES | 16 | Vanguard-Bach Guild | LP | 16 |
| EMS | AES | RIAA-12 | Vox | LP | 16 |
| Esoteric | RIAA | RIAA-12 | Westminster | RIAA | 16 |
| Haydn Society | LP | 16 | | | |

45 RPM records of all labels, except RCA, generally will require AES turnover and 12 db roll-off. For RCA, use RIAA settings.

78 RPM records labelled:

| | | | | | |
|---|---|---|---|---|---|
| Brunswick | EARLY 78 | 0 | EMI | EARLY 78 | 0 |
| Capitol | AES | RIAA-12 | HMV | EARLY 78 | 0 |
| Columbia (English) | EARLY 78 | 0 | London | EARLY 78 | 8 |
| Columbia (USA) | AES | 16 | Parlophone | EARLY 78 | 0 |
| Decca | AES | RIAA-12 | RCA-Victor | RIAA | RIAA-12 |

Please bear in mind that there is only one correct combination of turnover and rolloff for a given recording and that is the one which sounds best to you. Do not hesitate to experiment until you find the settings you prefer. Additional information concerning equalization of recordings appears in technical literature. "High Fidelity" magazine publishes an extensive tabulation at intervals and portions of the above list were compiled from this source, with permission of the publishers.

## NOTES ON USING THE WA-P2 PREAMPLIFIER

With the BASS and TREBLE control indicators in the vertical, or 12 o'clock position, the response of the preamplifier is essentially flat except for compensation supplied by the turnover and rolloff circuits in the PHONO position.

Be sure to reverse the line plug in the outlet for minimum hum. Also, after all connections are made, readjust the HUM control for the lowest noise level, using PHONO input. Set the BASS control at full clockwise and the ROLLOFF control to the EARLY 78 position so that maximum bass boost is used. As mentioned before, the setting of the HUM control is rather critical.

Occasionally, residual hum of a higher pitch will be evident even with the VOLUME control at minimum. If this occurs, try disconnecting the shield of the output cable at the point where it is connected to the main amplifier plug.

As explained in the Specifications (Page 5), no "loudness control" circuit is incorporated in the WA-P2. Space is provided for these controls if you should desire to use one of them. If a 3-section control is used, it may be necessary to clip off a corner of the chassis flange directly behind the control. This may be done easily with a pair of diagonal cutting pliers. Follow the manufacturer's recommendations for installing and using loudness controls.

## SELECTION OF ACCESSORY COMPONENTS

The range of accessory components for use in high-fidelity systems continues to expand. Every attempt has been made to provide in the WA-P2, sufficient flexibility to utilize future as well as current equipment of this kind. Remember that the preamplifier is only one important link in the chain. It cannot eliminate distortion or noise from other parts of the system.

For phonograph reproduction, we seriously recommend the purchase of a cartridge with a replaceable diamond stylus despite the higher first cost. Reduction in damage to records, better tracking and longer life will more than repay the extra original outlay.

Magnetic or reluctance types of cartridges are generally susceptible to external magnetic fields and they should be used only with turntables or changers equipped with motors designed to have very weak external fields. Ceramic and crystal cartridges are not affected in this way and great improvements have been made in the performance of this group of pickups.

In the speaker-enclosure field, a tremendous range in price (and performance) exists. Generally speaking, the performance can be predicted more from the size of the speaker enclosure than from the size of the speaker cone. Good bass reflex baffles, properly designed and adjusted, are probably the best low-cost enclosures available at present. Many of the Helmholz-resonator types of enclosures are excellent but they are more critical as to driver units, construction and other variables. Most speaker manufacturers supply excellent data on enclosure design.

Further discussion of the accessory problem is outside the scope of this manual. We recommend, for a serious and comprehensive review of the subject, any of the books mentioned in the bibliography. "Audio Engineering," "High-Fidelity," "Radio and Television News" and "Radio-Electronics" are publications which regularly feature articles on this subject.

## IN CASE OF DIFFICULTY

Recheck the wiring. Trace each lead in colored pencil on the pictorial as it is checked in the amplifier. Most cases of difficulty result from wrong connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.

Compare the tube socket voltages with those shown in the voltage table below. Readings within 20% of those shown may be considered as normal. If a discrepancy is noted, check the associated circuits carefully. Any component in those circuits should be suspected until proved satisfactory.

If voltages and tubes are normal, try the following procedure:

With the VOLUME control about half on and LEVEL control full on, touch terminal V1-3 with one lead of a .01 μfd condenser, hold the other lead in your hand. (CAUTION: Do not touch the chassis or any other metallic body with your other hand while making this test.) This should cause a decided increase in hum level at the speaker, if the circuit from this point is normal. Work back through the circuit, touching terminals V1-2, V2-1, V2-2, V2-6, V2-7, V1-8, V1-7, V3-6, V3-7, V3-1 and V3-2. The hum increase should be noticed at each point and will generally become greater as you work back. At some point, the circuit will appear to be dead and all circuitry following that stage may be disregarded in your trouble shooting. In this way, you can easily locate the source of the trouble and expedite its correction.

## VOLTAGE CHART

| SOCKET | Pin 1 | Pin 2 | Pin 3 | Pin 4 and 5 | Pin 6 | Pin 7 | Pin 8 | Pin 9 |
|---|---|---|---|---|---|---|---|---|
| V1 | 180 | 56 | 94 | H | 180 | 54 | 90 | H |
| V2 | 118 | 0 | 1 | H | 155 | 2.0 | 3.5 | H |
| V3 | 96 | NS | .64 | H | 98 | NS | 0.6 | H |
| Filter Condenser | Terminal ▲ 320 | | | Terminal ■ 270 | | Terminal ▲ 180 | | Terminal ▬ 140 |

All voltages are positive DC to chassis, measured with Heathkit V-6 Vacuum Tube Voltmeter with 11 megohm input resistance. Voltage between points marked H is 6.3 volts AC. NS indicates reading not significant. Measurements made with 320 volts DC input to filter system.

## BIBLIOGRAPHY

"The Saturday Review Home Book of Recorded Music and Sound Reproduction," Prentice Hall, Inc., New York

Read, O.; "The Recording and Reproduction of Sound," Howard W. Sams and Company, Inc. Indianapolis

Newitt, John H.; "High Fidelity Techniques," Rinehart Books, Inc., New York

## REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

## SERVICE

In event continued operational difficulties of the completed instrument are experienced, the facilities of the Heath Company Service Department are at your disposal. Your instrument may be returned for inspection and repair for a service charge of $5.00 plus the cost of any additional material that may be required. THIS SERVICE POLICY APPLIES ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned not repaired.

The Heath Company is willing to offer its full cooperation to assist you in obtaining the proper operation of your instrument and therefore this factory repair service is available for a period of one year from the date of purchase.

## SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted. Attach a tag to the instrument giving name, address and trouble experienced. Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot by held liable for damage in transit if packing, in HIS OPINION, is insufficient.

## SPECIFICATIONS

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

## WARRANTY

The Heath Company limits its warranty of parts supplied with any kit (except tubes, meters and rectifiers, where the original manufacturer's guarantee only applies) to a period of three (3) months from the date of purchase. Replacement will be made only when said part is returned postpaid, with prior permission and in the judgment of the Heath Company was defective at the time of sale. This warranty does not extend to any Heathkits which have been subjected to misuse, neglect, accident and improper installation or applications. Material supplied with a kit shall not be considered as defective, even though not in exact accordance with specifications, if

it substantially fulfills performance requirements. This warranty is not transferable and applies only to the original purchaser. This warranty is in lieu of all other warranties and the Heath Company neither assumes nor outhorizes any other person to assume for them any other liability in connection with the sale of Heathkits.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility or liability for any damages or injuries sustained in the assembly of the device or in the operation of the completed instrument.

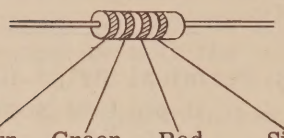
HEATH COMPANY
Benton Harbor, Michigan

# PARTS LIST

| PART No. | PARTS Per Kit | DESCRIPTION |
|---|---|---|
| **Composition Resistors** | | |
| 1-11 | 1 | 1.5 KΩ 1/2 watt |
| 1-44 | 2 | 2.2 KΩ 1/2 watt |
| 1-14 | 2 | 3.3 KΩ 1/2 watt |
| 1-20 | 1 | 10 KΩ 1/2 watt |
| 1-22 | 1 | 22 KΩ 1/2 watt |
| 1-67 | 2 | 39 KΩ 1/2 watt |
| 1-25 | 5 | 47 KΩ 1/2 watt |
| 1-26 | 1 | 100 KΩ 1/2 watt |
| 1-29 | 2 | 220 KΩ 1/2 watt |
| 1-35 | 4 | 1 megohm 1/2 watt |
| 1-37 | 2 | 2.2 megohm 1/2 watt |
| 1-74 | 1 | 18 megohm 1/2 watt |
| 1-4A | 1 | 8.2 KΩ 1 watt |
| 1-26A | 2 | 15 KΩ 1 watt |
| 2-84 | 2 | 1.5 KΩ 1/2 watt low-noise |
| 2-85 | 2 | 100 KΩ 1/2 watt low noise |
| **Controls-Switches** | | |
| 11-17 | 1 | 100 Ω ww control HUM |
| 10-35 | 5 | 500 KΩ comp. control LEVEL |
| 10-37 | 2 | 1 megohm comp. control VOLUME and BASS |
| 19-21 | 1 | 1 megohm comp. control w/switch TREBLE |
| 63-75 | 1 | Single-section rotary switch TURNOVER |
| 63-76 | 1 | Single-section rotary switch ROLLOFF |
| 63-74 | 1 | Double-section rotary switch SELECTOR |
| **Condensers** | | |
| 21-29 | 1 | 4.7 μμf ceramic |
| 21-9 | 1 | 100 μμf ceramic |
| 21-22 | 1 | 220 μμf ceramic |
| 21-23 | 1 | 420 μμf ceramic |
| 21-24 | 1 | 800 μμf ceramic |
| 21-25 | 1 | .0013 μfd ceramic |
| 21-26 | 1 | .003 μfd ceramic |
| 23-37 | 2 | .0022 μfd molded paper |
| 23-39 | 1 | .0047 μfd molded paper |
| 23-54 | 1 | .0082 μfd molded paper |
| 23-34 | 3 | .01 μfd molded paper |
| 23-50 | 4 | .022 μfd molded paper |
| 23-52 | 2 | .047 μfd molded paper |
| 23-53 | 4 | .1 μfd molded paper |
| 25-4 | 1 | 10 μfd 25 volt elec. |
| 25-29 | 1 | 40-40-40-40 μfd 300 volt elec. |
| **Miscellaneous** | | |
| 411-25 | 1 | 12AU7 tube |
| 411-26 | 2 | 12AX7 tube |
| 391-1 | 1 | Nameplate |
| 481-3 | 1 | Condenser mounting wafer |
| 595-89 | 1 | Instruction manual |

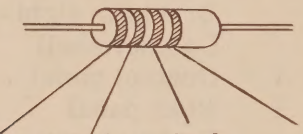
| PART No. | PARTS Per Kit | DESCRIPTION |
|---|---|---|
| **Sockets-Plugs-Terminal Strips-Knobs** | | |
| 434-16 | 1 | 9-pin tube socket |
| 434-43 | 2 | 9-pin tube socket, shielded |
| 434-42 | 7 | Phono input socket |
| 438-6 | 1 | Octal plug and cap |
| 438-4 | 4 | Phono plug |
| 431-11 | 4 | 5-lug terminal strip |
| 431-12 | 1 | 4-lug terminal strip |
| 431-16 | 1 | 2-lug terminal strip |
| 462-27 | 4 | Knob, small |
| 462-28 | 2 | Knob, large |
| **Metal Parts** | | |
| 200-M64 | 1 | Chassis |
| 204-M65 | 1 | Bracket, left-end |
| 204-M66 | 1 | Bracket, right-end |
| 90-M29F | 1 | Cabinet shell |
| 203-M58F76 | 1 | Control panel |
| 203-M59F79 | 1 | Rear panel |
| 205-M34F | 1 | Bottom plate |
| 207-M7 | 1 | Panel clamp |
| 206-3 | 2 | Tube shield |
| 206-23 | 1 | Switch shield |
| **Wire-Cable-Shielding** | | |
| 344-1 | 1 | length Hookup wire |
| 344-1 | 8 | lengths Hookup wire (8 colors) |
| 340-2 | 1 | length Bare wire |
| 343-3 | 1 | length Shielded cable |
| 346-1 | 1 | length Sleeving, 1/16" |
| 346-5 | 1 | length Sleeving, 1/4" |
| 347-1 | 1 | length 8-conductor cable |
| 206-24 | 1 | length Shielding, 3/16" |
| **Hardware** | | |
| 73-1 | 2 | 3/8" grommet |
| 73-4 | 2 | 3/16" grommet |
| 73-6 | 4 | 7/16" grommet |
| 207-5 | 1 | Cable clamp |
| 250-2 | 6 | 3-48 machine screw |
| 250-8 | 4 | #6 sheet metal screw |
| 250-9 | 2 | 6-32 x 3/8" machine screw |
| 250-31 | 20 | 6-32 machine screw |
| 250-46 | 12 | 6-32 self-tapping screw |
| 252-1 | 6 | 3-48 hex nut |
| 252-3 | 22 | 6-32 hex nut |
| 252-7 | 12 | Control nut |
| 253-10 | 12 | Flat metal washer, control |
| 253-21 | 4 | Flat metal washer, 9/16" |
| 253-15 | 1 | Flat fiber washer |
| 253-16 | 1 | Shoulder fiber washer |
| 254-1 | 20 | #6 lockwasher |
| 254-4 | 15 | Control lockwasher |
| 255-2 | 4 | #6 spacer, 3/16" |
| 259-1 | 2 | #6 solder lug |
| 261-4 | 4 | Rubber mounting feet |

## 1/2 WATT RESISTORS



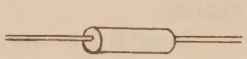
| | | | | |
|---|---|---|---|---|
| 1.5 KΩ | Brown | Green | Red | Silver, |
| 2.2 KΩ | Red | Red | Red | Gold or |
| 3.3 KΩ | Orange | Orange | Red | not marked. |
| 10 KΩ | Brown | Black | Orange | |
| 22 KΩ | Red | Red | Orange | |
| 39 KΩ | Orange | White | Orange | |
| 47 KΩ | Yellow | Purple | Orange | |
| 100 KΩ | Brown | Black | Yellow | |
| 220 KΩ | Red | Red | Yellow | |
| 1 megohm | Brown | Black | Green | |
| 2.2 megohm | Red | Red | Green | |
| 18 megohm | Brown | Gray | Blue | |

## 1 WATT RESISTORS



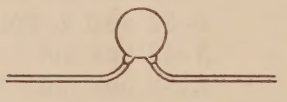
| | | | | |
|---|---|---|---|---|
| 8.2 KΩ | Gray | Red | Red | Silver |
| 15 KΩ | Brown | Green | Orange | Silver |

## CERAMIC CONDENSER



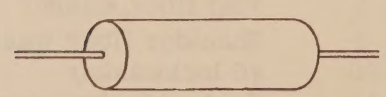
(Marked Numerically)

## CERAMIC CONDENSER



(Marked Numerically)

## MOLDED CONDENSERS



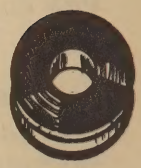
(Marked Numerically)

May have a single, dark band which may be ignored.

## GROMMETS

3/16"

3/8"



7/16"

## LOCKWASHERS

6-32

Control

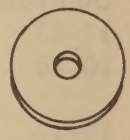
## SPACER

3/16"

## WASHERS

Control, Flat - (Metal or Insulating)

Shoulder



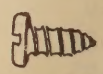
9/16 x 5/32 Flat

## SCREWS

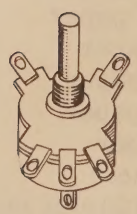
3-48 Machine

6-32 Machine

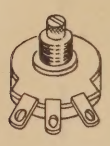
6-32 Self-tapping



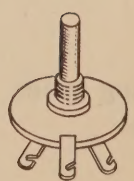
Sheet Metal



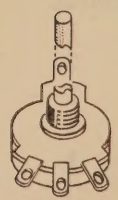
TREBLE CONTROL



LEVEL CONTROL



HUM CONTROL



VOLUME & BASS CONTROL

# HELPFUL KIT BUILDING INFORMATION

Before attempting actual kit construction read the construction manual through thoroughly to familiarize yourself with the general procedure. Note the relative location of pictorials and pictorial inserts in respect to the progress of the assembly procedure outlined.

This information is offered primarily for the convenience of novice kit builders and will be of definite assistance to those lacking thorough knowledge of good construction practices. Even the advanced electronics enthusiast may benefit by a brief review of this material before proceeding with kit construction. In the majority of cases, failure to observe basic instruction fundamentals is responsible for inability to obtain desired level of performance.

## RECOMMENDED TOOLS

The successful construction of Heathkits does not require the use of specialized equipment and only basic tools are required. A good quality electric soldering iron is essential. The preferred size would be a 100 watt iron with a small tip. The use of long nose pliers and diagonal or side cutting pliers is recommended. A small screw driver will prove adequate and several additional assorted screw drivers will be helpful. Be sure to obtain a good supply of rosin core type radio solder. Never use separate fluxes, paste or acid solder in electronic work.

## ASSEMBLY

In the actual mechanical assembly of components to the chassis and panel, it is important that the procedure shown in the manual be carefully followed. Make sure that tube sockets are properly mounted in respect to keyway or pin numbering location. The same applies to transformer mountings so that the correct transformer color coded wires will be available at the proper chassis opening.

Make it a standard practice to use lock washers under all 6-32 and 8-32 nuts. The only exception being in the use of solder lugs—the necessary locking feature is already incorporated in the design of the solder lugs. A control lock washer should always be used between the control and the chassis to prevent undesirable rotation in the panel. To improve instrument appearance and to prevent possible panel marring use a control flat nickel washer under each control nut.

When installing binding posts that require the use of fiber insulating washers, it is good practice to slip the shoulder washer over the binding post mounting stud before installing the mounting stud in the panel hole provided. Next, install a flat fiber washer and a solder lug under the mounting nut. Be sure that the shoulder washer is properly centered in the panel to prevent possible shorting of the binding post.

## WIRING

When following wiring procedure make the leads as short and direct as possible. In filament wiring requiring the use of a twisted pair of wires allow sufficient slack in the wiring that will permit the twisted pair to be pushed against the chassis as closely as possible thereby affording relative isolation from adjacent parts and wiring.

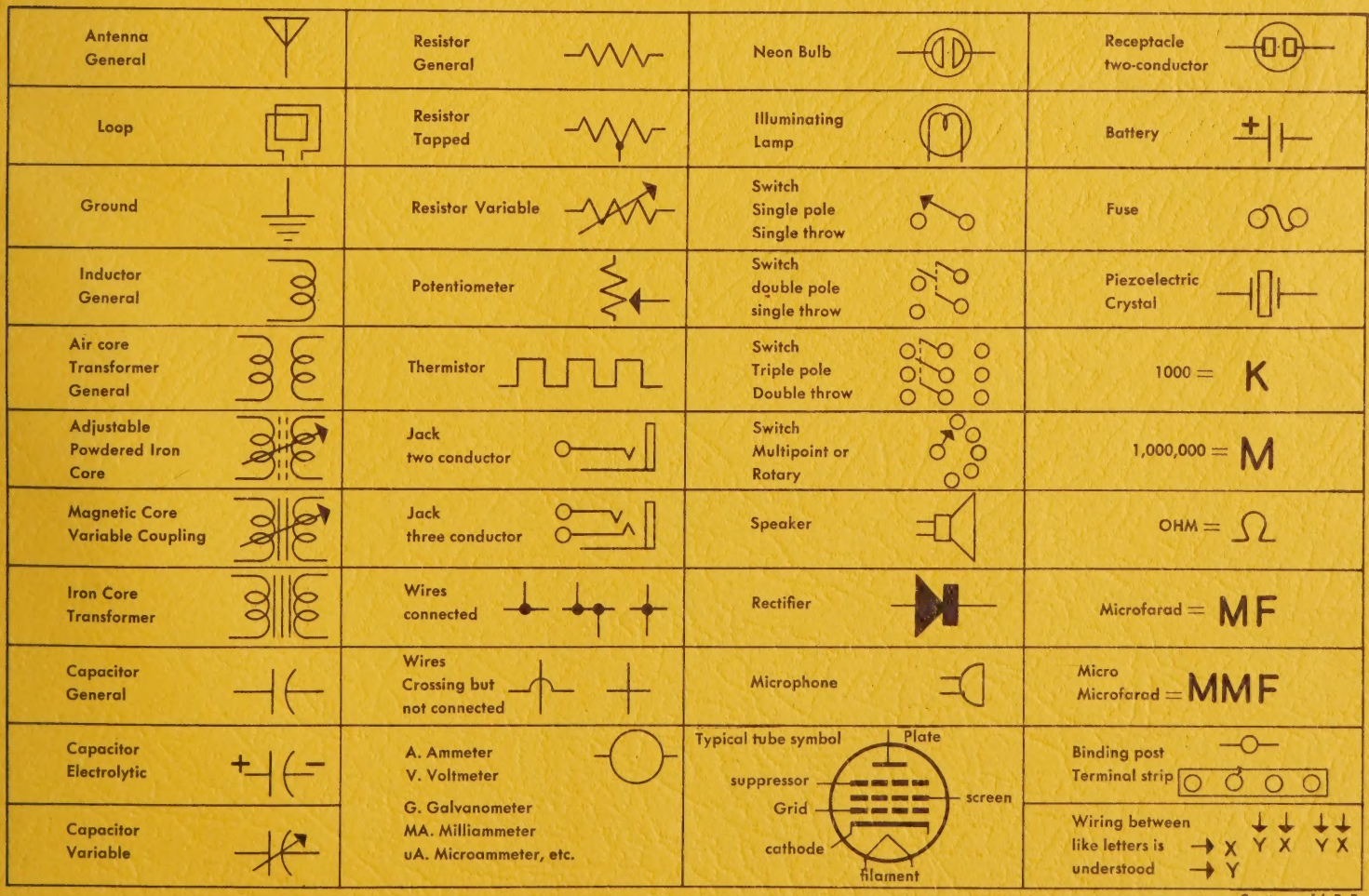
When removing insulation from the end of hookup wire, it is seldom necessary to expose more than a quarter inch of the wire. Excessive insulation removal may cause a short circuit condition in respect to nearby wiring or terminals. In some instances, transformer leads of solid copper will have a brown baked enamel coating. After the transformer leads have been trimmed to a suitable length, it is necessary to scrape the enamel coating in order to expose the bright copper wire before making a terminal or soldered connection.

In mounting parts such as resistors or condensers, trim off all excess lead lengths so that the parts may be installed in a direct point-to-point manner. When necessary use spaghetti or insulated sleeving over exposed wires that might short to nearby wiring.

It is urgently recommended that the wiring dress and parts layout as shown in the construction manual be faithfully followed. In every instance, the desirability of this arrangement was carefully determined through the construction of a series of laboratory models.

## SOLDERING

Much of the performance of the kit instrument, particularly in respect to accuracy and stability, depends upon the degree of workmanship used in making soldered connections. Proper soldered connections are not at all difficult to make but it would be advisable to observe a few precautions. First of all before a connection is to be soldered, the connection itself should be clean and mechanically strong. Do not depend on solder alone to hold a connection together. The tip of the soldering iron should be bright, clean and free of excess solder. Use enough heat to thoroughly flow the solder smoothly into the joint. Avoid excessive use of solder and do not allow a flux flooding condition to occur which could conceivably cause a leakage path between adjacent terminals on switch assemblies and tube sockets. This is particularly important in instruments such as the VTVM, oscilloscope and generator kits. Excessive heat will also burn or damage the insulating material used in the manufacture of switch assemblies. Be sure to use only good quality rosin core radio type solder.




Courtesy of I. R. E.

# HEATH COMPANY

*A Subsidiary of Daystrom Inc.*

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

**BENTON HARBOR, MICHIGAN**



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